Sky and TELESCOPE

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CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

The Editors Note ..

ASTRONOMICAL HISTORY tells of many "great comets" which have appeared to our parents and grandparents. But not since 1910, when Comet 1910a and Halley's blazed across the sky, have any spectacular comets been seen — comets which could attract the gaze of the man in the street without any encouragement or advice from his astronomical friends. Now the Southern Hemisphere and the tropics have been treated to the sight of what surely deserves to be called the Great Comet of 1947, although its present designation is Comet 1947n.

We are grateful to the individuals and observatories who sent us by air mail the reports and pictures of the comet which are published in this issue.

Dr. L. E. Cunningham, of the Students' Observatory, University of California, is investigating the relative orbits of the two nuclei into which the comet split. He reports that the comet will emerge from the vicinity of the sun in May, when it will probably be about 15th magnitude. From an ephemeris computed by Dr. Cunningham are taken the following positions for the second half of January, with magnitudes in parentheses computed according to the fourth power of the distance law and the sixth-power law, respectively: January 14.0, $22^h\ 00^m.5$, $-20°\ 24'$ (8.6, 10.6); 18.0, $22^h\ 08^m.6$, $-19°\ 13'$ (9.0, 11.1); 22.0, $22^h\ 15^m.9$, $-18°\ 09'$ (9.4, 11.6); 26.0, $22^h\ 22^m.6$, $-17°\ 10'$ (9.7, 12.1). An ephemeris by Dr. Jorge Bobone, of Cordoba Observatory, predicts the comet's position on January 30.0 as $22^h\ 28^m$, $-16°\ 19'$.

Observations of 1947n were made at the McDonald Observatory in Texas as early as December 15th and 16th; spectrograms were also taken at that time. By the 19th, the comet was reported as of magnitude 4, diffuse and without a nucleus, with a tail longer than one degree, as seen from the Lowell Observatory. Further observations continued at McDonald, and the nucleus was reported split on December 19th, when the two parts appeared of equal brightness. On December 20th and 21st, the 24-inch reflector at Yerkes Observatory was used by Dr. G. Van Biesbroeck for a series of plates. Three McDonald spectrograms obtained on hypersensitized 1N emulsion showed bands in the infrared region which have been identified tentatively with ammonia.

Dr. Balfour S. Whitney, of the University of Oklahoma, determined the comet's position for December 26th as at $21^h\ 0^m.5$, $-28°\ 6'.7$. He reported the two parts separated by 15 seconds of arc, and that they were more clearly resolved on red than on blue plates. The comet's total photographic magnitude was 7.0.

Comet 1947n is fading into history as it recedes from both the earth and the sun, but Comet Bester (1947k) is heading northward and increasing in brightness, probably to reach naked-eye brilliance. It passes perihelion the middle of this month, and although it may fade during March, its position for observation then will improve. Dr. J. S. Paraskevopoulos reported on December 28th that the comet was brightening, and had a tail about three degrees long on a 45-minute exposure taken with the 8-inch Bache at Harvard's southern station. Reference to the December, 1947, issue of **Sky and Telescope**, page 52, can be made for an ephemeris of Comet Bester which runs through April 7th of this year.

M. J. Bester, comet discoverer.

Three of last year's 14 comets were discovered by Michiel John Bester, who for 10 years has been an assistant at the Boyden station. Born 30 years ago at Colesburg, Cape, he was in business from 1933 to 1937. He was married in 1940 and has two daughters, six and three years old.

Another comet, in which Mr. Bester shares honors with E. Rondanina, of Montevideo Observatory, is Rondanina-Bester, 1947b, which was discovered on March 26th last year. Then it was of the 12th magnitude, but 10 hours later it was invisible on a plate showing stars of magnitude 12.5. A month later, when its predicted magnitude was 9.7, it surprised observers by shining at the 5th magnitude.

Douglas Berry, director of the comet section of the New Zealand Astronomical Society, describes the behavior of this comet in the October, 1947, issue of **Southern Stars**, New Zealand society magazine.

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COVER: The Great Comet of 1947 was for a short time a striking naked-eye object in the Southern Hemisphere and in the tropics. This photograph was taken by E. J. Casal at the Montevideo Astronomical Observatory on December 11, 1947, three days after the first spectacular appearance of the comet. (See page 87.)

BACK COVER: The southwestern portion of the Great Nebula in Andromeda, photographed on August 20, 1933, by John C. Duncan, Whitin Observatory, Wellesley College, with the 100-inch Hooker reflector at Mount Wilson Observatory. A Ross zero correcting lens was used, and the exposure was 2½ hours. The scale is about one inch to five minutes of arc. At the estimated distance of this spiral galaxy of 805,000 light-years, one minute of arc is about 235 light-years. The well-resolved condensation in the center of the picture is NGC 206. Note the resolution of the galaxy's spiral arms into individual stars and clusters. Dr. Walter Baade, of MountWilson Observatory, assigns most of these stars to population I, but some population II objects mingle with them. (See page 91.)

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The Great Comet of 1947

These reports are from the Southern Hemisphere. Further news of 1947n and the cometary year just passed may be found on page 86.

THIS SPECTACULAR OBJECT was first seen in South Africa on the evening of December 8, 1947, by practically everyone who happened to be out in the open under a clear sky. The observatory telephone rang almost continuously with local and long-distance calls from various parts of the Union of South Africa, and each person claimed to be the first to have seen the comet.

It was a magnificent object. The head pointed in the direction of the southwestern horizon at an altitude of only two or three degrees and the long, slightly curved tail extended upward for about 25 degrees, with its convex side toward the west. Naturally, there is always some degree of uncertainty in estimating the length of a cometary tail. All contributing factors, such as city lights, moonlight, weak and untrained eyes, cause the observer to minimize the length of the comet's tail. However, at the Boyden station of Harvard Observatory, situated on a kopje (hill) rising some 240 feet above the South African high veld (prairie-like fields), 15 miles east-northeast of the lights of the city of Bloemfontein, my staff and I agreed that the tail was *not less* than 25 degrees. The discrepancy with those who make it only 15 degrees long is quite understandable.

The comet and Venus, drawn by Rubens de Azevedo, Fortaleza, Brazil, on December 13, 1947. He estimates the magnitude of the nucleus then to have been 1.6. Detailed observations were made with a 61-millimeter refractor.

Observing conditions were far from ideal all over South Africa. The low altitude of the comet, the great length of the day (with the sun near the summer solstice), twilight, unsettled weather, and the moon, all affected our observations adversely. For a number of days following discovery, only rare photographs were possible, with only a few seconds' exposure each time. But the positions secured enabled a preliminary orbit based on a parabola to be computed at the Cape Observatory, and H. M. Astronomer at the Cape of Good Hope, Dr. J. Jackson, was kind enough to send me the following tentative orbital elements together with a search ephemeris.

The comet, photographed by J. S. Paraskevopoulos on December 17th, with the 10-inch Metcalf telescope at Harvard's southern station. In spite of the low altitude of the comet and the proximity of the moon, the exposure was 40 minutes.

Perihelion passage had already occurred at December 2.631, with the distance from the sun 0.1069 of an astronomical unit. The inclination of the orbit was given as about 137° 38′, with the longitude of the node 337° 20′ and the distance from node to perihelion 196° 3′. At the beginning the motion of the comet was eastward at the rate of about 15 minutes of time and northward six minutes of arc daily. Gradually, the rate of motion in right ascension has decreased to about five minutes daily, whereas that of declination has increased to 24 minutes of arc.

The duplicity of the nucleus. On December 10th, Dr. W. H. van den Bos, the Union Astronomer, while examining the head of the comet with the 26½-inch visual refractor of the Union Observatory at Johannesburg, observed that the nucleus was double. [See his report below.]

The multiplicity of the tail. On December 16th, a night of average clarity, I managed to obtain a 45-minute guided exposure with an ordinary 1-inch camera mounted equatorially by our mechanic, E. G. Burton, on the extreme south edge of the kopje. I operated the driving mechanism by hand. The brightness of the coma had faded and was then estimated to be between magnitudes 2.5 and 3, but the tail was still long. The moon, already four days old, was quite troublesome and in the field. Nevertheless, the plate showed the tail was a triple one (perhaps quadruple), consisting of two long components and a third short one.

The following night, December 17th, it was possible to use our 10-inch photographic Metcalf triplet telescope for a maximum exposure of 40 minutes. The plate disclosed that the tail was *quintuple.* The present position of the comet will permit our larger instruments to make further observations.

The comet has faded considerably and I fear that as the dark of the moon

On December 13th, with the Leiden 16-inch telescope at Johannesburg, this seven-minute exposure of the comet was taken. It shows the principal tail on a large scale, 90 seconds of arc per mm.

approaches, naked-eye observations will be impossible.

J. S. PARASKEVOPOULOS
Superintendent, Boyden Station
Harvard College Observatory
Bloemfontein, S. A.

December 28, 1947

THE BRIGHTEST COMET since 1910 was seen in South Africa by a large number of persons on Monday, December 8th. Letters received later at the Union Observatory show that from at least two different places it was already observed shortly after sunset on Sunday. The observatory was informed by telephone on Monday night, but too late to see the comet. Tuesday night was cloudy and the comet was not seen until shortly before setting, when it came from behind a low bank of cloud. It was then very brilliant, but we could not obtain reliable observations, only a very rough position. Wednesday night was clear and the comet was photographed for position with the 16-inch twin Rockefeller refractor of the Leiden southern station, situated on the grounds of the Union Observatory. It was also observed visually with the 26½-inch refractor, when it was at once seen to have two nuclei.

In spite of generally cloudy nights — this being our rainy season in South Africa — further observations could be obtained on most dates from December 10th onward, and the results were telegraphed to Dr. L. E. Cunningham at Berkeley and to Dr. J. Jackson at the Royal Observatory, Cape Town, who independently computed orbits. Curiously enough, the comet could not at first be observed at the Cape Observatory, as it was hidden by the bulk of Table Mountain and its satellite, Devil's Peak (for once aptly named, as one of the Cape astronomers wrote to us). Dr. Jackson used for his orbit our photographic positions of the 10th and 13th, with his own of December 16th.

Micrometer measures and estimates of the magnitudes of the two nuclei show curious changes. Allowance should be made for the difficulties of measurement caused by the low altitude, poor seeing, and the nebulous character of the object. Up to December 20th, when weather interfered, the following results were obtained concerning the two nuclei in the head of the comet:

Dec. 1947	*LST*	*P. A.*	*Dist.*	*Magnitudes*
10	$1^h\ 00^m$	192°	6″.3	4.5 - 8.5
13	0 57	166.3	7.74	5.5 - 8.5
14	1 03	159.3	8.04	
14	1 18	159.4	8.05	6.0 - 8.5
15	1 00	154.0	8.54	7.5 - 7.5
15	1 18	152.9	8.80	7.8 - 7.6
16	1 36	142.3	10.18	8.5 - 8.3
16	1 42	140.6	10.39	
17	1 19	138.5	9.93	9.0 - 9.5
17	1 34	139.5	9.51	9.0 - 9.5
18	1 23	134.8	10.90	9.0 - 9.6
18	1 45	135.3	10.96	9.0 - 9.5
19	1 29	134.7	11.39	9.3 - 9.7
19	1 44	132.5	11.38	
20	1 36	129.7	11.89	9.0 - 10.5
20	1 49	129.7	12.31	

On the 15th, when the two nuclei had suddenly become of the same brightness, they were also easily seen by the two photographic observers, Messrs. Wesselink and Johnson, in the 8-inch guider of the Leiden 16-inch telescope.

W. H. VAN DEN BOS
Union Astronomer
Union Observatory
Johannesburg, S. A.

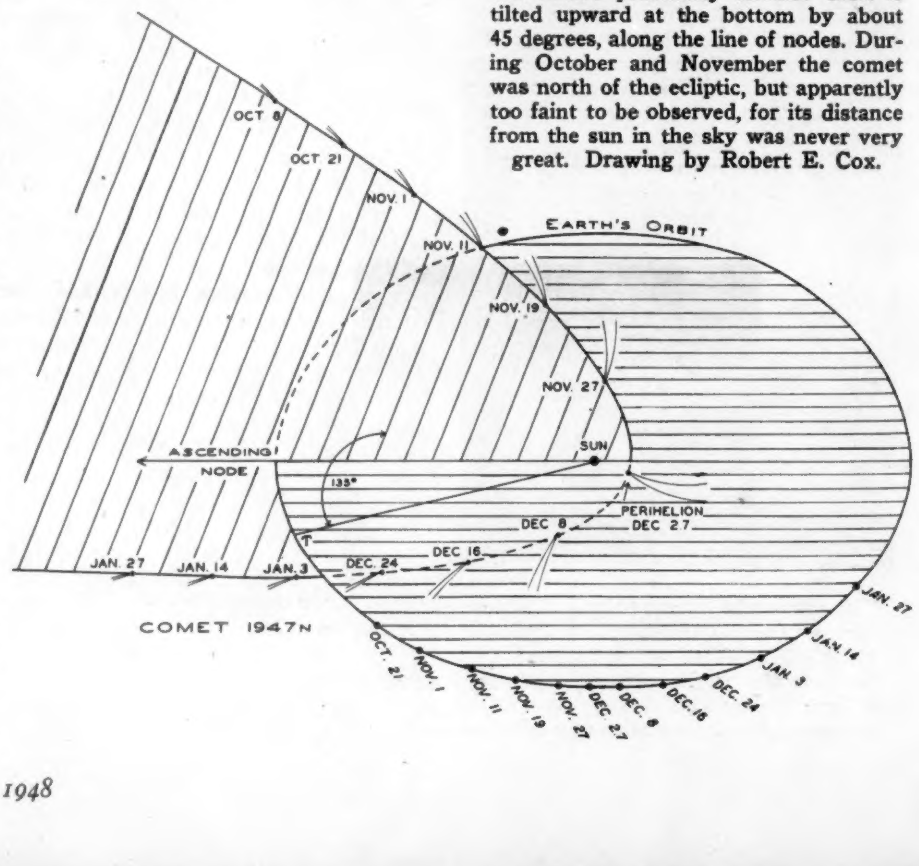
December 29, 1947

UNFORTUNATELY, as far as we in Sydney have been concerned the comet was somewhat of a disappointment. It was reported in the newspapers as having been seen in other places and having been the brightest comet since 1910, but we had here a period of cloudy weather and did not see it until the evening of December 16th, by which time it had faded very much. It was then magnitude 4.7, by comparison with extra-focal images of neighboring stars, and both to the naked eye and on the photographs we obtained it was much inferior to Comet 1941c (Comet de Kock). The magnitudes subsequent to this were 5.8 on December 22nd, 5.7 on the 23rd, and 6.2 on the 25th.

HARLEY WOOD
Government Astronomer
Sydney Observatory
Sydney, Australia

December 29, 1947

IN MELBOURNE on December 9th at 8:30 p.m. I had my first view of the comet. It was then in the southwest, at about the same altitude as Venus. The tail stretched nearly straight upward, broadening and curving southwards toward the top. It was about 12 degrees long. The nucleus was about magnitude zero. The comet looked like a scimitar held over the city. In spite of the city lights it was a striking sight, certainly the finest comet I have seen since Halley's (an early memory). On December 10th, I saw the comet again; it was then a little higher than Venus,



With cardboard, a three-dimensional model can be set up from this diagram. The parabola representing the comet's orbit is in the plane of the paper, while the earth's practically circular orbit is tilted upward at the bottom by about 45 degrees, along the line of nodes. During October and November the comet was north of the ecliptic, but apparently too faint to be observed, for its distance from the sun in the sky was never very great. Drawing by Robert E. Cox.

but it had become somewhat fainter.

I regretted that I was so far from my observatory and without instruments to photograph the comet. (Most unfortunately, the Melbourne Observatory was closed down some time ago.) On my return to Sydney a few days later, however, I found that the skies had been constantly cloudy there. On December 17th I obtained a 14-minute exposure with a short-focus camera. The comet was very low and the sky very bright, partly due to the proximity of the moon. On the negative the tail shows for about three degrees. Another exposure the next night was fogged owing to bright moonlight.

This December has been the second wettest since records were started in Sydney. It has rained nearly every day, and we have had nearly 10 inches so far this month.

D. O'CONNELL, S.J., director
Riverview College Observatory
Riverview, New South Wales
December 29, 1947

DURING the first 10 days of December we experienced overcast evening skies—almost 10/10. HMNZS *Arbutus* sailed from Wellington en route to Sydney on Sunday, December 7th. Evidently she cleared the extensive cloud bank on the evening of the 9th, for she reported seeing the comet then as a good naked-eye object.

On the 10th, my family and I, through a hazy break in overcast sky, observed what appeared to be Venus, but we remarked that Venus should not have been in that position at that time — we apparently saw the nucleus of the comet. By the next night we saw the comet as a good naked-eye object; the following evening the sky was excellent and we had, I should say, our best view of it. It was south of Venus, about the same height above the horizon, with a definitely orange-colored nucleus, and a tail about 15 degrees long, resembling a scimitar. I would estimate the end of the tail as 1½ degrees wide.

My 3-inch Dollond refractor was set up in Cornwall Park on the 14th, where a number of interested persons observed the comet, also using binoculars and field glasses. Later we set up a 4½-inch Zeiss refractor, but the comet then proved to be a disappointing telescopic object. The next night we had good seeing, also. Thereafter, observing conditions were poor until the 18th, when we picked the comet up with difficulty at 9:15 p.m. Now it was a good telescopic object.

Overcast skies again prevailed until this evening, but I was unable to pick up the comet with the 3-inch Dollond and 80 power. The moon is full, and it would appear that we have seen the last of Comet 1947n, except, perhaps, with large telescopes.

It has been a great experience, and to lovers of the starry sky the unexpected appearance of the naked-eye comet has been a great thrill. I feel privileged to have observed it so many times and to have the eyesight, time, opportunities, and telescope to view this one of the many wonders of the heavens.

ROY V. SYMONDS
Box 64
Hastings, New Zealand
December 27, 1947

SINCE December 11th, I have been observing the comet, which appears with considerable brilliance in the constellation of Sagittarius. My search for it since the day of its first discovery elsewhere in the Southern Hemisphere had previously failed because of clouds in the western evening sky. On the 11th, the comet was 10 degrees to the south of Venus, with its tail some eight degrees long and inclined some 30 degrees toward the south with respect to the vertical. The nucleus had a brightness I believe to be about 2nd magnitude.

VICTOR A. ESTREMADOYRO
Enrique Palacios 167
Chorrillos, Lima, Peru
December 13, 1947

LA PLATA OBSERVATORY received, the night the comet appeared for the first time, many requests for information, and several telegrams from Uruguay. Our astronomers could not observe it on the 8th for our observatory is situated inside a park and surrounded by very high trees, but in the Cosmic-Physics Observatory of San Miguel (about 50 kilometers northwest of Buenos Aires) the comet was watched from its first appearance by the Jesuit seminarist Bessonart.

From the 9th of December onward, our astronomers Tapia, Itzigsohn, Baldini, Jascheck, and Rogatti have been observing the comet nightly, with very few nights lost due to clouds. The brightness of the nucleus was diminishing, magnitude 2.0 on the 9th, 5.5 on the 19th, 6.5 on the 24th, and 7.0 on the 30th of December. The tail was at first 20 degrees long. Dr. Pascual Sconzo, on the basis of three observations, computed the following elements: perihelion passage, December 2.6030; perihelion distance, 0.10940; inclination, 138°.275; longitude of the node, 336°.550; distance to perihelion, 196°.158.

But the most interesting phenomenon was that on Sunday night, December 14th, the comet nucleus appeared divided into two separate parts, by a distance of nine seconds of arc, according to measures made with the micrometer of the Gautier equatorial of 433-millimeter aperture; the nuclei differed by one stellar magnitude in brightness. Position angles and separations of the nuclei were later observed to be 145°, 9″.5 on the 17th; 120°, 13″.5 on the 25th; and 115°, 15″.5 on the 29th; all data for 0^h Universal time. The difference in magnitude of the nuclei first decreased to 0.5 from the 16th to the 19th, then was at least two magnitudes on the 22nd, but by the 30th the nuclei were about equal in brightness.

At the La Plata Observatory, with an astrographic camera, N. Tapia made this four-minute exposure on December 14th at 9:15 p.m. The comet's position then was 19 hours 32 minutes right ascension, 34 degrees 20 minutes south declination.

G. O. WALLBRECHER, director
Observatorio Astronomico
La Plata, Argentina
December 31, 1947

Added in press: In a letter dated January 6th, Dr. J. S. Paraskevopoulos, who has now photographed the comet with the Harvard 60-inch reflector, points out that only the nucleus, and not the comet, has split in two. This is an internal phenomenon of the coma, or head of the comet. The separation of the nuclei components remained at about 20 seconds of arc (along the axis of the comet) from December 31st to January 4th.

WEATHERWISE

"Some people are weatherwise but most are otherwise," said Benjamin Franklin, so it is fitting that headquarters for a popular meteorology magazine, *Weatherwise*, should be at the Franklin Institute, Philadelphia, Pa. The first issue of the new publication will be that of February, 1948, and it is to be published bi-monthly by Amateur Weathermen of America, an organization devoted to spreading information about weather and promoting the establishment of more amateur weather stations in the United States. Those interested in joining the AWA and thereby subscribing to *Weatherwise* should communicate with David M. Ludlum, director, AWA, Franklin Institute, Philadelphia 3, Pa.

Amateur Astronomers

Operation ATM at Howard University

AT THE CONVENTION of amateurs in Philadelphia in July, 1947, Dr. Harlow Shapley spoke of a Dr. William Calder and his work in physics and astronomy at Howard University, a college for the colored subsidized by the government in Washington, D.C. I telephoned Dr. Calder upon my return from the convention, as I was interested in obtaining information concerning the telescope which I had started. All I didn't know about telescope making would fill the Library of Congress, and my mirror had more fingerprints on it than the files of the FBI.

In response to Dr. Calder's invitation I went to Howard University and visited the telescope making workshops. The room in which the mirrors are ground and polished has 17 automobile housings anchored in the concrete floor, and on these are bolted round wooden tops big enough to hold 12-inch tools. The students journey around these table tops during the various grinding and polishing stages. There is a small tester to check the radius of curvature, and in the testing room, which is blacked out, an especially designed precision Foucault testing device. The students were well trained in sighting the paraboloid and detecting the unwanted figures as well. Every parabolic figure was checked by Dr. Calder; he seems to have a genius for feeling the paraboloid.

The assembling room was a beehive of activity, drilling machines and aluminum files going full blast in mass-production fashion. The equatorial mounts are made entirely of aluminum, the tube of the open-frame type. Each mirror is a 6-inch f/8. The ocular train is collimated in the assembling room.

I found Dr. Calder a young, unassuming gentleman with a deep interest in astronomy and music. He is now in charge of the physics and astronomy department at Agnes Scott College, Decatur, Ga.

In November, 1947, he had the first meeting of a newly formed astronomy club in Atlanta. The radio and press helped him broadcast the news, and although rain poured down on the night of the meeting, 75 prospective members ventured out. Orders for blanks and telescope equipment have been placed. In a few months, Atlanta will have a batch of telescopes which will spread astronomy throughout that area.

MAURICE S. A. DELANEY
Washington, D.C.

THIS MONTH'S MEETINGS

Chicago: On Tuesday, February 10th, Dr. Joel Stebbins, of the Washburn Observatory, will address the Burnham Astronomical Society on the "Color of Stars and Nebulae." The meeting is held at the Chicago Academy of Sciences at 8 o'clock.

Detroit: The February meeting of the Detroit Astronomical Society is scheduled for Sunday afternoon, the 8th, at 3 o'clock in Room 211 of Wayne University. The retiring president, William Schultz, Jr., will hold an "Astronomical Quiz."

Geneva, Ill.: At the meeting of the Fox Valley Astronomical Society on Tuesday, February 3rd, there will be a lecture on "Ancient Astronomy" by Frank Hancock. Meetings are held in the council chamber of the Geneva City Hall at 8:00 p.m.

Madison: "Maps and Map-making" will be discussed by Professor A. H. Robinson, of the University of Wisconsin department of geography, at the February 11th meeting of the Madison Astronomical Society, at 8 o'clock in the Washburn Observatory.

New York: Dr. Fred L. Whipple, of Harvard College Observatory, will address the meeting of the Amateur Astronomers Association on February 4th, Wednesday, at 8 p.m. in the American Museum of Natural History. His topic is "The Origin of the Solar System."

Pittsburgh: The Amateur Astronomers Association of Pittsburgh will meet on Friday, February 13th, at 8:15 p.m., in the Buhl Planetarium. The annual quiz will be held, with Edwin S. Hider, vice-president of the association, as quizmaster. Participants will be chosen from the audience, with prizes for the winners.

Washington, D. C.: Alan H. Shapley, of the National Bureau of Standards, will lecture at the regular monthly meeting of the National Capital Astronomers on February 7th, at 8 p.m. in the National Museum. His subject will be "Solar and Radio Storms," and the lecture will be accompanied by motion pictures.

League Regional Conventions

According to **The Observer,** publication of the Yakima Amateur Astronomers, Yakima, Wash., the regional convention of the Northwest Region of the Astronomical League will be held June 12-13th, at Portland, Ore. At its annual meeting in December, Yakima voted to join the league.

The Stargazer, publication of the Amateur Astronomers Association of Pittsburgh, states that plans are now being made for the Astronomical League regional convention to be held in Pittsburgh sometime during the month of May. In charge of arrangements is Charles Leroy, of the Pittsburgh group. Coinciding with the convention, there will be a two-week display of amateur-made optical and astronomical equipment at the Buhl Planetarium.

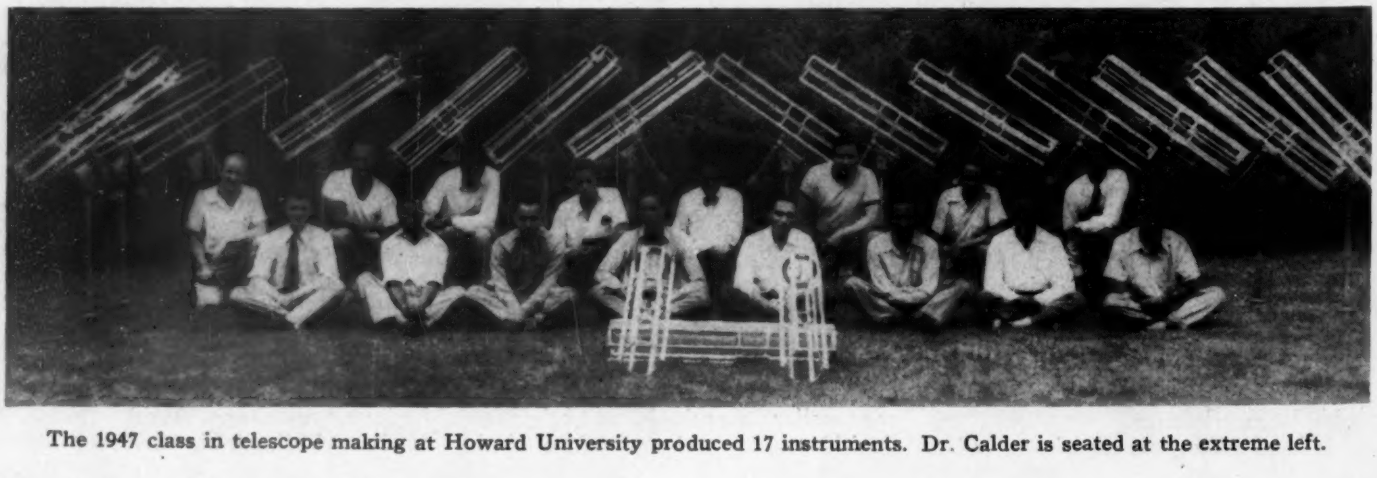
This convention, scheduled for May 15-16th, is for the purpose of organizing the Middle Atlantic region, and all groups in southern New Jersey, Delaware, the District of Columbia, Maryland, Virginia, West Virginia, Kentucky, Ohio, Indiana, Michigan, and Pennsylvania, are urged to make plans for sending delegates.

Amateurs in Winston-Salem

The Forsyth Astronomical Society, after its first year of activity, has about 20 members. Three telescopes, a 3-inch, an 8-inch, and a 9-inch, have been made by the members, and a library of 40 textbooks acquired. Finding a permanent home is a current project.

We have had lectures this year by members and by the faculty of the local college. Our club belongs to the Astronomical League, and we all take **Sky and Telescope** as members of the club. We shall be glad to hear from any interested persons in this vicinity.

KENNETH SHEPARD, secretary
703 W. E. Blvd.
Winston-Salem, N. C.



The 1947 class in telescope making at Howard University produced 17 instruments. Dr. Calder is seated at the extreme left.

Columbus Meeting

By Joseph L. Gossner and Simone Daro Gossner
Harvard College Observatory

The 78th MEETING of the American Astronomical Society was held from December 28th to 31st, at the Emerson McMillin Observatory of Ohio State University, where Dr. J. Allen Hynek assumed the function of host with competence and efficiency. The first sessions for papers were scheduled for Monday morning, December 29th, but on Sunday evening a reception for the members of the society was held at the residence of President H. L. Bevis of Ohio State University. With surprise and delight, the astronomers discovered that the "Pleiades," whose presence had been announced on the program, turned out to be a group of pretty members of an honorary sorority.

Foremost events of the meeting were the second Henry Norris Russell lecture and a symposium on the two types of stellar population. The latter was held at the Perkins Observatory, Delaware, Ohio, at the invitation of its director, Dr. N. T. Bobrovnikoff. In addition, some 45 papers constituting the regular program were presented; many of these will be reviewed in future issues of *Sky and Telescope*.

The Russell lecture was given on the evening of December 29th by Dr. Walter S. Adams, director emeritus of the Mount Wilson Observatory, who spoke on "The Gaseous Clouds of Interstellar Space," from the point of view of observational data. Summing up investigations ranging over the past 40 years, the lecturer recalled the first discovery by Hartman in Potsdam of the narrow and stationary lines of ionized calcium in the spectrum of Delta Orionis which Eddington interpreted as having interstellar origin. In later years many other stars were found to have similar lines, and more elements were identified as existing in clouds in space.

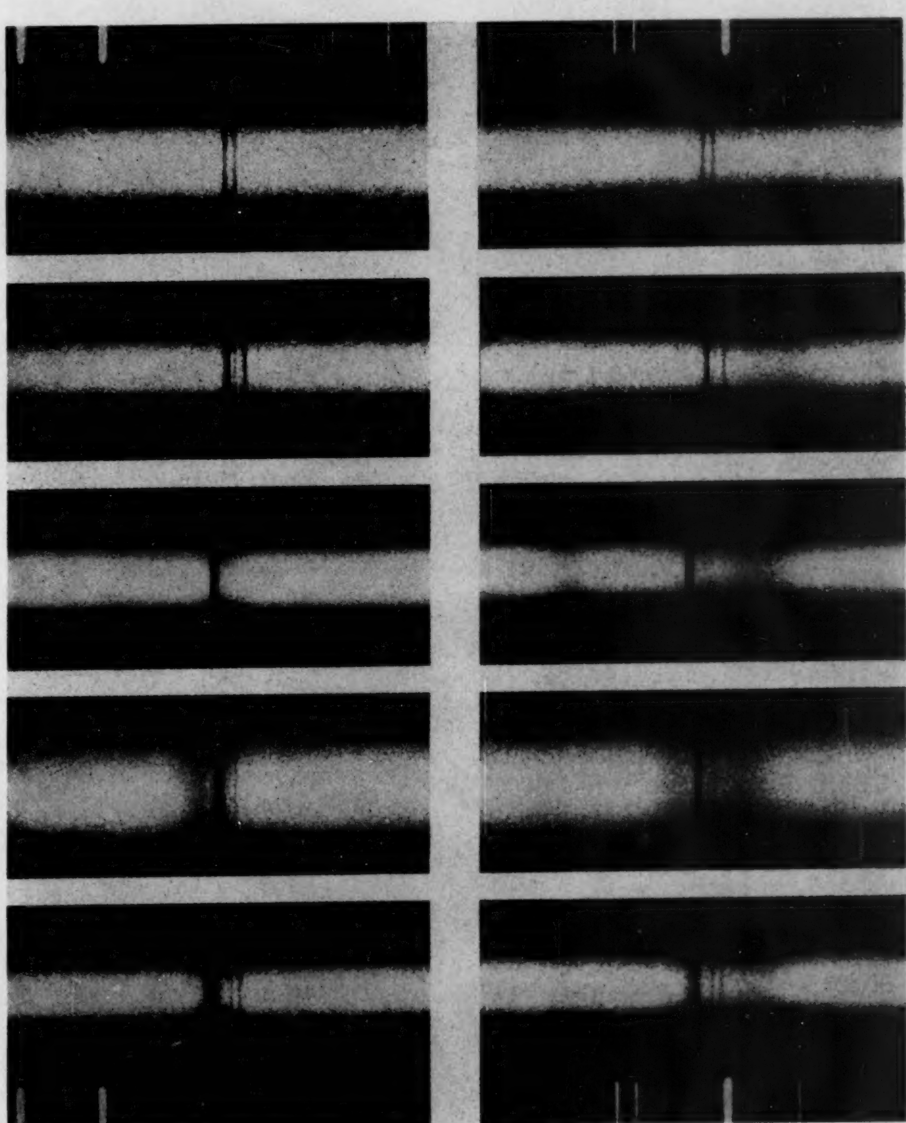
In 1936 came the important discovery by Beals of the doubling of interstellar H and K lines in the spectra of a few stars. This phenomenon was attributed to the existence — on the path of the rays from such a star — of two interstellar clouds of different radial velocities. Up to this day the following elements and compounds have been identified in interstellar gases: neutral potassium, sodium, calcium, and iron; ionized calcium and titanium; neutral CH and CN molecules; ionized CH.

Dr. Adams undertook to investigate the spectra of bright *O* and *B* stars with the highest practicable dispersion, employing the coude spectrograph of the 100-inch telescope. The hot *O* and *B* stars have normal spectra with very few stellar lines; thus these stars furnish the best spectra in which to detect the absorption lines produced by the interstellar gases. Dr. Adams divides his study into three parts:

"The first is the search for the interstellar lines other than H and K; the second, an examination of H and K for structure and multiple components; and the third, estimates of the intensities of all interstellar lines, and measurements of the radial velocity given by all lines, including components of H and K."

The first part of the investigation has led to the following conclusions: A few stars show all the lines (26) previously recognized as interstellar with the probable exception of the line at wave length 4227 (neutral calcium); neutral CN usually appears with neutral CH, the latter being much less abundant than ionized CH; neutral iron and neutral calcium, when present, occur in stars with strong H and K lines; finally, a similarity of interstellar lines is observed very often in stars close together in apparent position.

Complexity can best be detected in the H and K lines because of their greater strength. As might be anticipated, the



Portions of the spectra of five stars, showing the sharp interstellar lines of calcium (K, left; H, right) taken with high dispersion at Mount Wilson Observatory. For Kappa Aquilae (top) the lines are double, and correspond to interstellar gas clouds with radial velocities of 13.1 kilometers per second toward the sun, and 8.2 away from the sun. The fourth star, Mu Sagittarii, has triple interstellar lines, while HD 199478 (in Cygnus), at the bottom, is described by Dr. Adams as having almost certainly five interstellar lines, but with two of them too close to measure. In this case, two of the clouds have velocities of recession (corrected for the sun's motion) of 41 and 60 kilometers per second, respectively. Reproduced from the "Astrophysical Journal."

frequency of complex lines and hence of multiple clouds differs greatly in different parts of the sky. The radial velocities furnish the best criteria for the identification and extent of individual clouds. The results indicate that there must be present in interstellar space a considerable number of thin gaseous clouds moving with high velocities against a background of much larger clouds whose sole movement appears to be in most cases that of galactic rotation. Most of the clouds show strong concentration toward the galactic plane, but occasionally some thinner ones are found at high galactic latitudes.

The question has been raised, "whether the gaseous clouds with which we are dealing are truly interstellar . . . or whether at least some of them may not be circumstellar and related to the stars, either through origin or some other kind of association." In answer to this, Dr. Adams said:

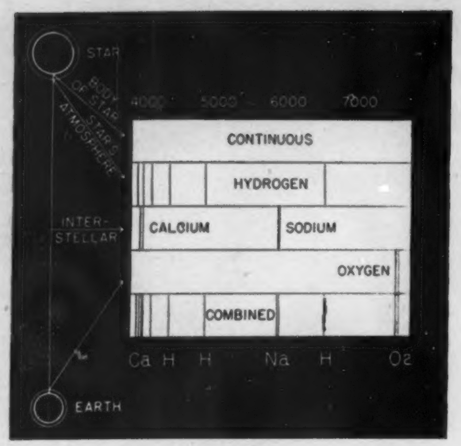
"The huge clouds, identified by their motions in the line of sight, which cover great areas in Orion, Sagittarius, Cygnus, and other parts of the sky, and cannot be related to any particular stars or groups of stars, must be regarded as truly interstellar . . . the gradation in size from the very widespread clouds to those of much smaller size seems to be a fairly orderly one."

Lines of molecular origin, such as of neutral and ionized CH, might possibly be confined to the general neighborhood of the stars observed, since they do not exhibit the same complexity as the H and K lines, but Dr. Adams pointed out several arguments against this idea, the only possible exception being the Pleiades star cluster.

The second Russell lecture will be published in the *Astrophysical Journal*, together with samples of the many excellent spectra Dr. Adams has taken.

Another Mount Wilson astronomer, Dr. Walter Baade, led off the symposium, which was entitled, "The Relation Between Spectral Characteristics and Motions of Stars," and was concerned chiefly with stellar populations I and II. There is good evidence for the existence of two distinct groups of objects in the universe. Members of population I are well concentrated in the equatorial plane of the Milky Way and form a highly flattened system. By contrast, the population II members form the nuclei of galaxies like our own and M31 and intermingle at times with the stars of type I. They form an ellipsoidal system in less rapid rotation and contain such objects as globular clusters, cluster-type variables, red giants, and planetary nebulae.

Dr. Baade pointed out that even by 1920 the work of Shapley on globular clusters had already led to the conclusion that the Hertzsprung-Russell diagram for these objects differs completely from that for the stars in our own re-



This diagram shows how the light from a star's surface is absorbed by various gases on its way to the earth's surface, each absorption adding certain dark lines to the original continuous spectrum. From "Atoms, Stars and Nebulae," by Goldberg and Aller.

gion of the galaxy, which Dr. Baade terms "the local swimming hole." In the globular clusters the bluest stars are less luminous than usual main-sequence stars of the same types, while there is a separate giant branch more luminous than the ordinary giants. This pattern is now well established from data for 10 globular clusters.

A parallel study on the open galactic clusters by Dr. R. J. Trumpler, of the University of California at Berkeley, who gave the concluding paper in the symposium, had meanwhile shown that these objects contain only stars of the main sequence and normal giant stars. The existence of two distributions has thus been established. As Dr. Trumpler pointed out, no transitional case has ever been found, so that the type of population may now be considered a criterion for discriminating between open and globular clusters.

In 1938, there followed at Harvard the discovery of the extragalactic systems in Sculptor and Fornax. Their conspicuous lack of blue giants pointed to their similarity with globular clusters, which was emphasized further by the presence of red giants and cluster-type variables, and the absence of dust.

The next step was Dr. Baade's resolution of the nucleus of the great galaxy in Andromeda, M31, and of several of the elliptical galaxies. The nucleus of M31 exhibits a stellar population of type II, whereas the objects characteristic of type I — blue giants, gaseous nebulae, classical Cepheids, and dust — appear in the outer regions (see back cover). It is further evident that population II intermingles with population I. The elliptical nebulae and close spiral galaxies are of type II, while the open Sc-type spirals and the arms of Sb spirals are unmistakably made up of population I objects. And where the blue giant stars (population I) appear, there is interstellar obscuring matter as well.

Photographs of the Sagittarius region, in the presumed direction of the galactic center, have yielded results comparable to those obtained in M31. A great many faint red stars suddenly appeared at about the 16th magnitude, together with numbers of cluster-type variables — as many as 600 per square degree. Cluster-type variables are characteristic of type II, so there is good indication that the nucleus of our galaxy is also of this population. Incidentally, this criterion has served to establish that the Magellanic Clouds are of type I, since not a single cluster-type variable has ever been observed in them.

But our local swimming hole is not free from outsiders. Oort, in 1926, had established that the *G* and *K* giants observed to have high velocities in our neighborhood have different characteristics from other stars of the same spectral types. These high-velocity giants and cluster-type variables appear to have escaped from the nucleus of the galaxy and to be moving in highly eccentric orbits through our region of space.

Dr. P. C. Keenan, of Perkins Observatory, in collaboration with Drs. W. W. Morgan and Guido Münch, of Yerkes Observatory, discussed the anomalies of these high-velocity giants, of which Epsilon Andromedae, Gamma Leonis, and Arcturus are typical examples. These stars show weakened CN bands (stellar) with some indication of slightly strengthened hydrogen lines. As these differences show up as well or better under low dispersion, there is an expectation that objective-prism plates of large areas of the sky can be used for the discovery of these high-velocity stars.

Further evidence of type II is given by the faint blue dwarfs found in high galactic latitudes by Zwicky. Humason's spectra show their dwarf characteristics and establish that these stars are not white dwarfs, as had been expected.

Dr. A. N. Vyssotsky, of the Leander McCormick Observatory, presented an analysis of stellar motions in our neighborhood. From the McCormick determinations of the constants of galactic rotation, Dr. Vyssotsky finds justification for assuming that a large percentage of the mass of the galaxy lies in the direction of the galactic center, and that the stars in our neighborhood move, therefore, in orbits around the galactic center which are subject to the same Keplerian laws that govern the motions of the planets in the solar system.

In accordance with Dr. Baade's suggestion that stars of type II are wandering through our region of the galaxy, Dr. Vyssotsky pointed out that the red giants within 750 parsecs of the sun differ considerably from other stars in both their distribution and dynamical characteristics — he called them *émigrés* from the center. His four arguments

are that they have a distribution perpendicular to the galactic plane different from other stars; their numbers increase more rapidly toward the galactic center; their velocity ellipsoid is more nearly spherical than that of the main-sequence stars; the equipartition of energy established for main-sequence stars does not obtain for the red giants.

For the red dwarf stars, also, the revolution around the center of the Milky Way system differs from the motion of stars like the sun. The observations which some have interpreted as evidence of certain dispersed moving clusters Dr. Vyssotsky now sees as resulting from the general decrease in stellar densities with increasing distance from the galactic center, together with the fact that main-sequence white and yellow stars in general move in orbits of smaller eccentricities than orange and red dwarf stars.

Dr. G. P. Kuiper, of Yerkes Observatory, summarized his work on the Hertzsprung-Russell diagram for stars whose trigonometric parallaxes are known with sufficient accuracy. He estimates the density of stellar material in space to be 0.04 to 0.05 the sun's mass per cubic parsec, while Oort places the total amount of material at 0.093; thus, about half of the matter in our region of the Milky Way is interstellar dust and the other half is in the stars. Ninety-five per cent of all the nearby stars are in the main sequence, and 95 per cent of these are fainter than the sun; three per cent are white dwarfs, one per cent subdwarfs, and one per cent all others, including giants and supergiants. An important suggestion by Dr. Kuiper was that the subdwarfs have a low hydrogen content. This latter property might well be characteristic of population II and apply, for instance, to the nuclei of M31 and our galaxy.

The relation of variable stars to the two types of stellar population was reviewed by Dr. Cecilia Payne-Gaposchkin, of Harvard. Classical Cepheids show a distribution of radial velocities characteristic of the galactic rotation as well as a concentration to the galactic plane, and the periods of classical Cepheids are greatest toward the center; these periods also fall off with increasing distance above and below the plane of the galaxy. There is a second group of Cepheids of longer periods and different light curves (W Virginis stars) which appear at distances from the plane greater than 500 parsecs.

On the other hand, the numbers of the very rapidly varying cluster-type stars increase toward the galactic center, and they show the smallest density changes perpendicular to the galactic plane that are found for any type of variable.

Dr. Gaposchkin divides the long-period variables into "short-long," with periods less than 250 days, and "long-long," of more than 350 days. The short-longs are analogous in distribution to cluster-type variables while the long-longs follow the classical Cepheids. In motions and distribution, intrinsically variable stars seem to fall in the sequence from type II to type I in the order: cluster-type and W Virginis Cepheids; short-long-period variables; long-long-period and low-luminosity semiregular variables; high-luminosity semiregular variables; classical Cepheids.

Other celestial objects than stars are also being classified by astronomers. Dr. R. Minkowski, of Mount Wilson Observatory, presented evidence for assigning planetary nebulae to population II. He has discovered an additional 137 planetaries by investigating all objects (on a series of objective-prism plates) containing the emission line of hydrogen alpha and little or no continuous spectrum. From the now known 291 planetaries, he established a concentration toward the galactic plane with increasing numbers toward the galactic center. Their dimensions indicate that some planetaries may be as far away as the galactic center, thus producing a distribution not unlike that of the globular clusters. Very few planetaries are seen in the direction of the anticenter. In this respect, we may mention that Dr. Bart J. Bok, of Harvard, in a paper presented at the meeting, reported his failure to detect any known object at a distance from the sun of more than 3,500 parsecs toward the anticenter region.

The traditional society dinner was held in Columbus on Tuesday evening. Dr. Joel Stebbins, past president and toastmaster for the occasion, called successively on Dr. Otto Struve, of Yerkes Observatory, who gave information concerning the 1948 meeting of the International Astronomical Union in Switzerland; on Dr. B. Stroemgren, of Copenhagen Observatory, who recalled

(Continued on page 102)

Members and guests at the 78th meeting of the American Astronomical Society, Columbus, Ohio, December 29, 1947.

NEWS NOTES

By Dorrit Hoffleit

THE LANGLEY

Dr. Samuel P. Langley, the inventor in 1880 of the bolometer, was a pioneer in measuring the heating power of the sun, which is conveniently expressed in terms of a unit heretofore without a specific one-word designation: the amount of solar radiation received on one square centimeter capable of raising the temperature of one gram of water one degree centigrade. It is fitting that this unit be named a *langley*, abbreviated *ly*. This is the decision of a recognized group of American meteorologists and astrophysicists.

Science Service points out that recommendation for the adoption of the term langley had previously been made in 1942 in the *Handbuch der Physik*, one honor to American science the Nazis failed to censor.

AURORAE

The November *National Geographic Magazine* contains a comprehensive, instructive, and beautifully illustrated article, "Unlocking Secrets of the Northern Lights," by Dr. Carl W. Gartlein, of Cornell University. For the past eight years, supported in his researches by the National Geographic Society, Dr. Gartlein has been photographing, observing, and studying aurorae: finding out how high they are in the atmosphere, how frequently seen from different geographic localities, in what manner their forms change, and how well correlated they are with sunspots and other phenomena.

Much of the work has been done in close collaboration with Professor C. L. Henshaw, of Colgate University, 53 miles distant from Dr. Gartlein's own observing post. They have obtained some 300 pairs of simultaneous photographs of aurorae, from which heights are determined. It was thus found that most aurorae occur at about 100 miles, though some may be as low as 35 miles, but never lower. The highest aurora ever recorded, by Stoermer in Norway, was over 600 miles above the surface of the earth, proving that our atmosphere extends at least that high, for aurorae occur only where there are atoms to be excited by particles coming from the sun.

Spectra of aurorae have revealed that only oxygen and nitrogen atoms are involved, not the light hydrogen which might be expected to become gravitationally separated toward the top of the atmosphere.

The most frequent occurrences of the northern lights are not at the north pole, but in an oval zone about 20 degrees in radius around the north geomagnetic pole. The latter is in northwestern Greenland, about 12 degrees from the geographic pole. In the most favored auroral zone, which passes through northern Norway, central Hudson Bay, Point Barrow, Alaska, and northern Siberia, about 243 aurorae a year may be seen. This is to be compared with only about 50 at the geomagnetic pole, and one in 10 years as far south as Mexico.

There is much yet to be done in the study of aurorae. Dr. Gartlein gives grateful acknowledgment to many observers in Canada and the United States who have contributed observations. However, "Many more observers are needed, professional and amateur ... all over the world, who have some knowledge of astronomy and are willing to put in some serious work." If you wish to help, write for instructions either to Dr. Gartlein at Cornell University, Ithaca, N. Y., or to the National Geographic Society, Washington 6, D. C.

NEW THEORY ON EARTH'S INTERIOR

In his address as retiring chairman of the Cape Centre of the Astronomical Society of South Africa, R. B. Borcherds suggests a new theory to describe the characteristics of the earth's interior on the basis of variations in condition rather than composition. Assuming a temperature gradient of one degree for every 90 feet of depth, he finds that observed discontinuities in the transmission of earthquake waves at depths of 7½, 23, and 38 miles can readily be attributed to changes of state due to high temperature and pressure. He then describes a transitional region between 750 and 1,800 miles within which depths the temperature and pressure are estimated to increase respectively from 44,000° to 105,000° centigrade and from 5,150,000 to 12,300,000 pounds per square inch.

For the earth's center, although temperatures as high as a million degrees have been inferred, a value of 250,000° is generally considered too high. The central pressure is calculated in the neighborhood of 50,000,000 pounds per square inch. Under these conditions an ounce of hydrogen, which occupies about 11 cubic feet at the surface of the earth, would be compressed into 0.001 to 0.003 of a cubic foot. Even 100,000° is thought to be above the critical temperature for any of the known elements. "No conceivable pressure applied to these substances at this temperature would cause them to liquefy or solidify." Hence the South African scientist believes the earth's center to be in a gaseous, although highly compressed, state. Moreover, the gas would be in the elementary and even ionized state; compounds would produce much higher densities than the known average for the earth of 5.52. At the center, gaseous oxygen, for example, might have a density of anything from five to 12, or even greater.

The old nickel-iron theory for the earth's core was partly developed to explain the earth's magnetic properties, but at high temperatures the iron would lose its magnetic properties. Moreover, if a rotating body develops magnetism, as recently found for the stars, the iron-core hypothesis is unnecessary. The editor of the *Monthly Notes* of the Astronomical Society of South Africa invites comments on Mr. Borcherds' theory.

NEW PRINTING TECHNIQUES

A catalogue of proper motions being issued by the Cincinnati Observatory is probably the first astronomical publication to have utilized a new punch-card controlled typewriter for the preparation of copy for the photoengraving reproduction process. The catalogue of 2,300 stars contains the results from meridian-circle observations begun at the observatory in 1907. It is a supplement to a catalogue published 25 years ago which contains data on precession, secular variations, proper motions, and positions of 4,683 stars.

The work was begun by the late Elliott S. Smith and carried on by two former directors, J. G. Porter and E. I. Yowell. The present director of the observatory, Dr. Paul Herget, is applying punch-card methods to a variety of astronomical problems.

HONORS GALORE

It would indeed be space-consuming to list all the honors bestowed upon Dr. Harlow Shapley during his career as director of the Harvard College Observatory. During the past year alone he has been awarded honorary degrees by Denmark and India, and elected to foreign honorary membership in the French Academy. Recently, word was received of another foreign honorary membership, in the Italian Accademia Dei Lincei. The name, Academy of the Lynxes, implies that the members are expected to examine scientific subjects with lynx-eyed keenness. The society, founded in 1603, is the oldest continuously active general science organization on this planet, its activities having been suspended only during part of the recent war years by order of Mussolini.

Its most illustrious past member was astronomer Galileo Galilei. At present it has, besides Dr. Shapley, two other American members, Dr. Ross Harrison, Yale embryologist, and Dr. Arthur H. Compton, physicist and chancellor of Washington University, St. Louis.

The Energy of the Sun and Stars

By Lawrence H. Aller

Kirkwood Observatory, University of Indiana

TO PRIMITIVE MAN the sun was an object of never-ending wonder and worship. Its annual northward pilgrimage presaged the liberation of his home and hunting grounds from the icy tyranny of winter. That his life depended on this celestial object was well appreciated, as the rites of many early religions so well attest. Somehow the sun was akin to fire, that mysterious phenomenon that drove away the cold, the dark, and wild beasts.

As the race emerged from childhood, superstitions were gradually replaced by appreciation of the order in the motions of the planets, stars, and the sun, and natural explanations were found for wind, rain, thunder, and even the tides. The path has been long but the ascent has become swifter. The regularity of celestial phenomena, such as eclipses, was established by the Chaldeans 2,000 years before these events were fully explained by Newton. The origin of the energy so liberally poured forth by the sun and stars was a more perplexing problem whose solution has required the advanced knowledge of modern atomic and nuclear physics.

The sun is larger than a million earths and has about 330,000 times as much mass as the earth. Insofar as the surface composition can be regarded as typical of the sun as a whole, we may say that it is composed mostly of hydrogen and helium, with liberal amounts of impurities such as calcium, carbon, iron, magnesium, oxygen, and sodium.

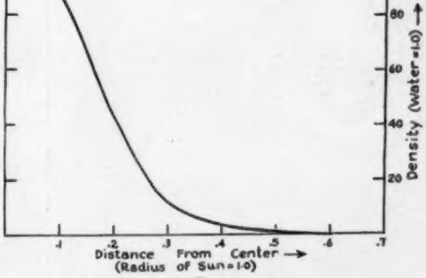
The energy output of the sun is enormous by our standards. We can measure the amount of energy reaching the earth by the rate at which the sun heats water or warms a blackened silver disk exposed to its rays. The earth and other planets intercept only a tiny fraction of the energy of the sun — all the rest passes out into space and is wasted, as far as we can judge. The total radiation of the sun is equivalent to 5.08×10^{23} horsepower. If we paid for this at the rate of one cent per kilowatt hour, then the entire cost of the second world war — one trillion dollars — would purchase the sun's energy for but a hundred millionth of a second!

Whence is this vast energy output derived? If the sun were made of pure coal and enough oxygen were supplied to burn it, the sun would burn out in 6,000 years, a tiny fraction of the time man has existed on the earth. The sun is not burning — its power derives from some other source. Many years ago, Helmholtz, a German physicist, suggested that the contraction of the sun and the consequent heating of the gases of which it is composed supplied the solar energy. A shrinking of a few hundred feet a year would suffice to supply the observed energy output, hence no change in the apparent size of the sun would have occurred in historical times, but in geological times it is another matter.

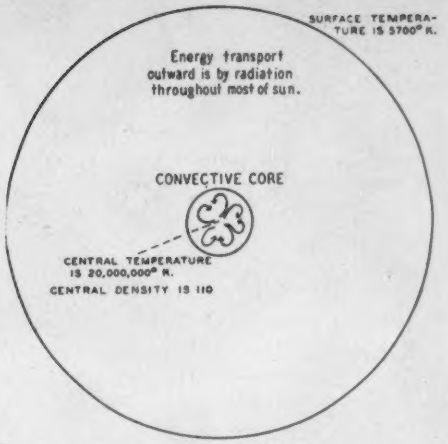
But even by contraction the sun could not have supplied energy at its present rate for more than 20 million years, and the record of the rocks reveals that life has existed on the earth's surface closer to a thousand million years. Since life is a fearfully fragile phenomenon, this means that the sun must have been shining at very close to its present rate for a million millenia. No chemical or mechanical process will do; we must turn to subatomic or nuclear processes wherein the very atoms themselves are transformed.

Our first guess might be that the sun is made almost entirely out of uranium. Under natural conditions, this element disintegrates into lead with the emission of high-energy radiation, electrons (beta rays), and helium nuclei (alpha particles). The process is very slow. It would take two thousand million years for a pound of uranium to change half into lead. A uranium sun would last long enough, but the output of energy would not suffice to prevent the oceans on the earth from freezing solid. This idea, appealing as it is, must be abandoned, although we are on the right track.

Next we might inquire whether the high densities and temperatures that exist in the center of the sun could play a role. The nuclear physicist can tell us the temperatures we must have for



The internal densities in the sun, in terms of the density of water, are here plotted against distance from the center (sun radius equals 1.0). This and the two illustrations on page 97 are from "Atoms, Stars and Nebulae," by Leo Goldberg and Lawrence H. Aller.



The energy generated near the center of the sun, where the temperature and density are extremely high, is transported by large-scale convection currents, while in the outer regions it is carried by radiation, largely in the form of soft X-rays.

the atoms themselves to be transformed. Fortunately, this question is not as difficult to answer as one might suppose. The sun is gaseous throughout, even though its average density is greater than that of water — about that of soft lignite coal. Through most of the solar interior the temperature is so high that the electrons are stripped off the atoms and the gas may be compressed to a very high density and still retain the properties a physicist or chemist associates with the term "gas."

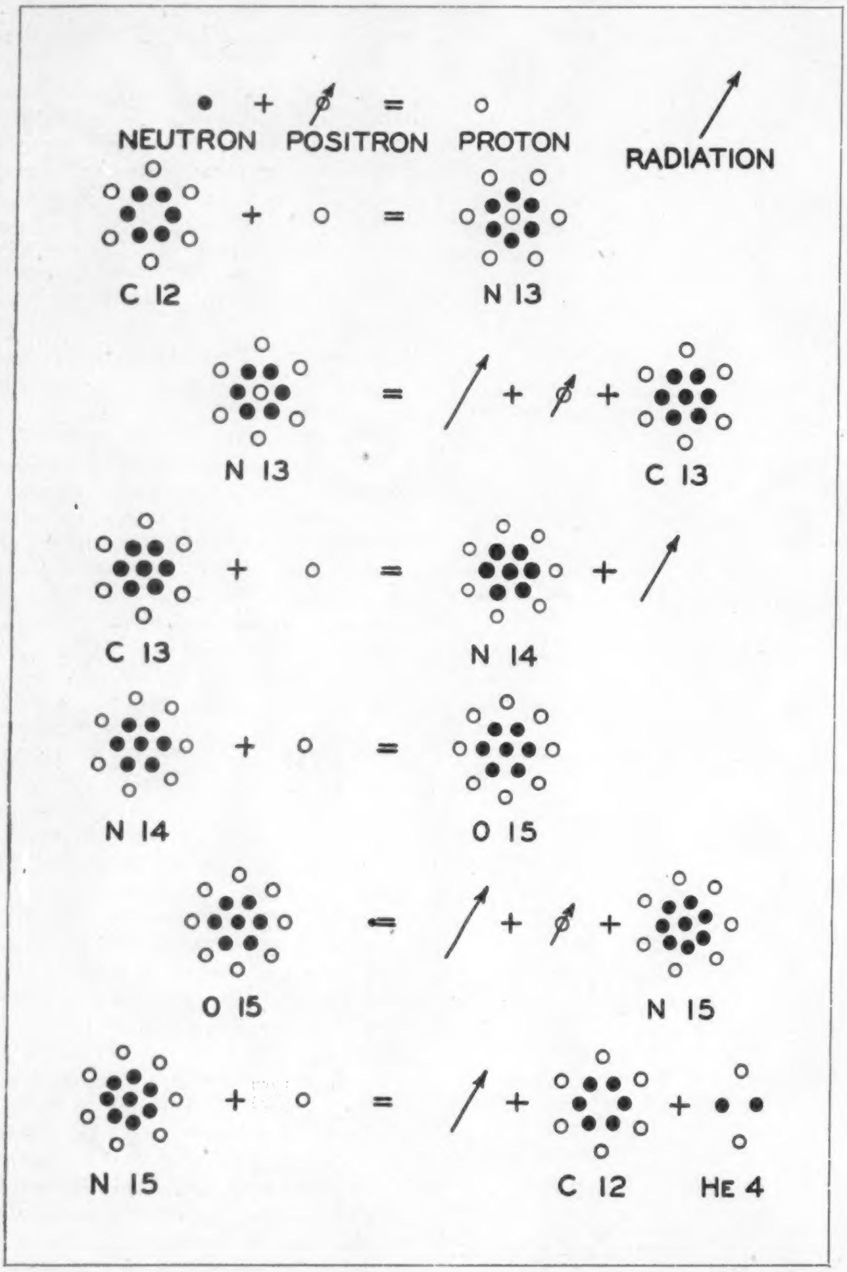
In some way energy is generated in the interior and passes to the surface of the sun and other stars, whence it escapes into space. The way in which the energy flows is determined by the rate of temperature increase as we go into the star. If this rate is high the energy transport takes place by large-scale convective currents, much as a room is heated by air currents rising from a hot stove and circulating about. Throughout most of the star the energy is passed from point to point by light waves — the material is hot and absorbs and emits radiation — and the energy, mostly in the form of soft X-rays, gradually works its way to the surface. The rate of flow of radiation will depend on the temperature of the material and on its composition. In the deep interior, where the temperature is a million degrees or more, iron will be much more effective at blocking radiation than hydrogen or helium.

Furthermore, the star must be a permanent affair and therefore in balance. At each point the pressure of the gas must offset the weight of the overlying layers, just as the pressure in the earth's atmosphere equals the weight in the atmosphere above a unit area at any given altitude. The pressure of a gas is proportional to the temperature and to the number of particles per cubic inch. A pound of hydrogen completely broken down into its constituent electrons and

protons supplies more particles than a pound of, say, iron which has been completely broken down into iron nuclei and electrons. To produce the same pressure, the iron must have a higher temperature than the hydrogen.

The pressure within a star is determined by the weight of the layers above, that is, by the mass of the star, and hence the temperature in the interior will depend on the mass and, as we have seen, on the composition as well. Therefore, if an astronomer is given the mass, luminosity, radius, and composition of a star, he can compute the temperature and density in the deep interior with the aid of the aforementioned physical considerations. In this way it is found that the central temperature of the sun is about 20 million degrees centigrade, and the central density is about 100 times that of water. The vast bulk of the interior of the sun is hotter than a million degrees.

At these temperatures the stripped atoms are jostled violently against one another. The impacts may be so severe that the nuclei of the atoms themselves are transformed. Thus a proton (hydrogen nucleus) colliding with a carbon nucleus under conditions prevailing in stellar interiors may be captured by the latter to form a nitrogen nucleus of atomic weight 13. A high-energy X-ray is emitted in the process. Subsequent changes in the nitrogen nucleus caused by further bombardment by protons may turn it into oxygen, which in turn breaks up into carbon and helium. Thus, the energy of the sun and similar stars appears to be generated in a very special process called the carbon cycle, wherein four hydrogen nuclei are cemented into helium while carbon acts as the catalyst, that is, as a necessary participant in the process although it itself is not used up.



The carbon cycle, proposed by Bethe to explain the energy generation in the main-sequence stars. The key to the symbols is given in the topmost equation: neutron plus positron equals proton. Note that the end product of the carbon cycle is the original carbon 12 atom and a helium atom.

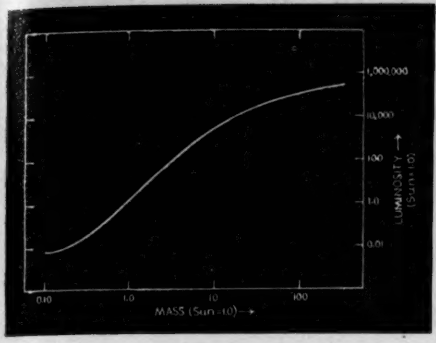
On the scale of the relative weights of atoms, a hydrogen atom has a mass of 1.00813, while a normal helium atom has a mass of 4.00386. Therefore, four hydrogen atoms exceed the mass of a helium atom by one part in 141, and this excess mass is converted into energy in accordance with the formula, $E = mc^2$, where c is the velocity of light in centimeters per second and m is the mass in grams. This basic relation, derived by Einstein, is the fundamental relation between mass and energy. In order to shine at its present rate, the sun must annihilate four million tons of matter every second, but the mass of the sun is so great that it can go on shining for thousands of millions of years to come before it exhausts its supply of hydrogen fuel. Bethe found that at the temperature and density of the center of the sun, energy generation by the carbon cycle would suffice nicely to account for the observed energy output and to insure its continuance throughout all of geological time.

Although the carbon cycle gives an excellent explanation for the energy output of the sun and similar stars, difficulties appear when we attempt to apply it to giant or very luminous stars. The troubles are of two kinds. If, with the methods followed for the sun, we calculate the internal temperatures and densities of a giant star such as Capella, we find that the internal temperatures are too low for the carbon cycle to operate. Other nuclear processes might work, but they all involve light and terrestrially rare elements such as heavy hydrogen (deuterium), lithium, boron, or beryllium, and it is difficult to conceive of the giant stars as being composed primarily of them.

Perhaps gravitational contraction plays a role in energy generation, as Helmholtz had suggested for the sun; in this event the life of a giant star must be unduly short.

Among the most interesting objects in the sky are the Cepheid variables, pulsating stars many times larger than the sun. The periods of pulsation of these objects depend on their respective densities — the greater the density the shorter the period. If these stars were contracting, their densities would slowly increase and their periods would shorten. The best known of these variables, Delta Cephei, has been observed for 200 years and no shortening of period has been found. Hence gravitational contraction appears not to be the source of energy generation, at least in the Cepheids.

Very hot blue stars appear to operate



Stars of the greatest intrinsic brightness are in general the most massive, as this mass-luminosity diagram shows. The scale is logarithmic in each co-ordinate.

by the carbon cycle, but here the energy output per pound may be a thousand times greater than in the sun. Such a star will expend its fuel in a few million years, even if made almost entirely of hydrogen, hence such stars cannot have been shining as long as the sun. Either they have existed in some non-luminous state for a long period and have burst into incandescence recently or they derive their energy from some process wherein all the mass is converted into energy. Nuclear physics provides no basis for the latter alternative and we are forced to the conclusion that the brightest jewels of the firmament are newcomers. Recent investigations suggest that the highly massive and luminous stars are formed from condensations of dust and gas in interstellar space.

What will happen to the sun when it exhausts its hydrogen fuel? With no other source of energy to draw on it will contract rapidly to a size not much greater than the earth and to a density about a million times that of water. Such stars, white dwarfs, appear to be plentiful in space; the best known of these objects is the companion of Sirius, which has a density of 2½ tons per cubic inch and a mass nearly as great as the sun's. This star shines feebly, apparently by gravitational contraction, with a luminosity about 1/360 that of the sun. Ultimately, the star will shrink down to a size little larger than the earth, completely cold and dark.

If the initial phase of a star's existence appears to be an opaque cloud of dust and gas with a density thousands of times lower than the best vacuum a physicist can produce on the earth, the final stage is a ball so dense that a teaspoonful of its material at the earth's surface could scarcely be moved with a crowbar.

We have decoded but a few pages of the book of the stars. Although the main facts appear to fall roughly in

Some stars are extremely large. These supergiants may be compared in size with the earth's orbit, indicated by the dotted circles.

some kind of coherent pattern, a vast amount of work must be done both from the observational and theoretical points of view before we shall have an adequate picture of the nature of the sun and stars.*

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*An important new advance on the observational side of the problem is McKellar's discovery that the relative abundances of the carbon isotopes C^{12} and C^{13} vary from star to star (for very red stars). Both of these isotopes play roles in the carbon cycle, and if the surface composition of a star is any index of what goes on inside, the observed isotope rates may prove of great value in the study of stellar interiors.

TERMINOLOGY TALKS — J. Hugh Pruett

Celestial Equator

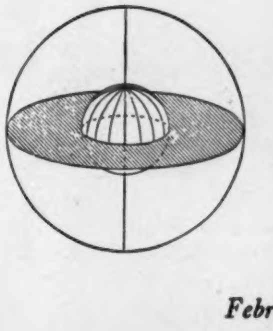
In astronomical books we usually find the brief statement that the celestial equator is the intersection of the plane of the earth's equator and the celestial sphere.

The terrestrial equator is an imaginary line drawn entirely around the earth midway between the north and south poles. If we consider also all the "filling" inside of and encircled by this circumference curve, we have a thin disk — theoretically *without* thickness — 7,927 miles across, or the equatorial diameter of the earth. A straight line started from any point on the circumference and drawn to the opposite point will touch the "filling" all along the route. Were this a small figure placed in a horizontal position, it would present a perfectly level surface. Every point in it is then "in the plane" of the equator.

But anything "in line" with our above-described disk, whether inside of or beyond its outer boundary, is in its plane. Let us suppose that we add to it all around with perfectly transparent material so that it extends out into space a million, a billion, a trillion miles. It has not yet reached the distance of any known star. This imaginary figure continues to expand thousands of times farther until it has seemingly touched many stellar objects all around its circumference. These stars are "in the plane" of the earth's equator. Now suppose that it is possible to have the outer rim of our invisible, extended disk marked on the far-away heavens by a line of delicate light. This luminous circle extending entirely around the sky becomes the *celestial equator*.

The distance to this circle is infinite, and there is no parallax effect even when viewed from "the ends of the earth." Exactly the same stars that seem to be crossed by the celestial equator when viewed from the earth's equator also lie in it as seen from any latitude whatever. Although in reality this mythical circle does not present itself to our sense of sight, astronomers refer star positions to it just as terrestrial latitudes are referred to the earth's equator.

Fig. 1. The equatorial plane. Adaptation from "Astronomy," by Russell, Dugan and Stewart.



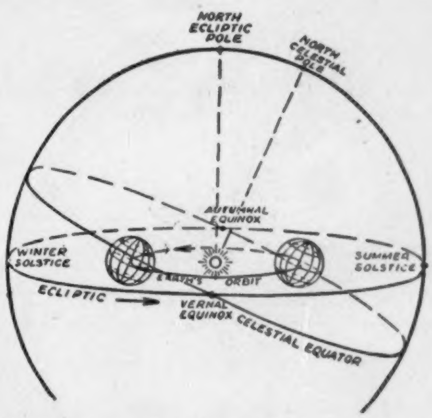


Fig. 2. The relation of ecliptic and equator, and their equinoctial intersections. From "Astronomy," by Robert H. Baker.

Ecliptic

The axis of the earth is not upright in respect to the plane of its orbit around the sun, but is inclined 23½°, as shown in Fig. 2. This means that the planes of the earth's equator and orbit cross at this angle. The sun is in the plane of the orbit, and the principal planets as well as our moon move in paths that cross it at small angles.

Now let us extend the plane of the earth's orbit as we did that of the equator until it touches the celestial sphere. Then we shall "illuminate" this distant curve so that earth dwellers may readily see it. This circle all around

(Continued on page 102)

CLOSE-UP OF MARS

BY ROBERT R. COLES, *Hayden Planetarium*

The surface features of Mars can be photographed in infrared light, as the left half of this Lick Observatory composite shows. The right half was taken with ultraviolet light.

MYSTERIOUS MARS is the answer to the Sunday feature writer's prayer and the cherished object of the science-fiction author's fondest dreams. Ever since Schiaparelli's discovery in 1877 of the strange markings which he described as *canali,* Mars has been carefully observed and photographed at every favorable opposition, in an effort to discover its hidden secrets. But, while much has been learned about this neighbor world, it still poses many perplexing problems to challenge our curiosity.

One of the planets easily observed with the naked eye, Mars has been known to man since before the dawn of history. The first person to view it through a telescope was Galileo, and the Dutch astronomer Huygens made a sketch of Mars in 1659 which is believed to be the first drawing of the planet. He showed some of the irregular markings that can be seen in the telescope, features which gradually came to be recognized as permanent. And in 1666 Cassini measured Mars' period of rotation as 24 hours and 40 minutes; today it is precisely determined to be 24 hours, 37 minutes, 22.58 seconds. This high accuracy is a result of more than 300 years of observation of Mars since the telescope was invented.

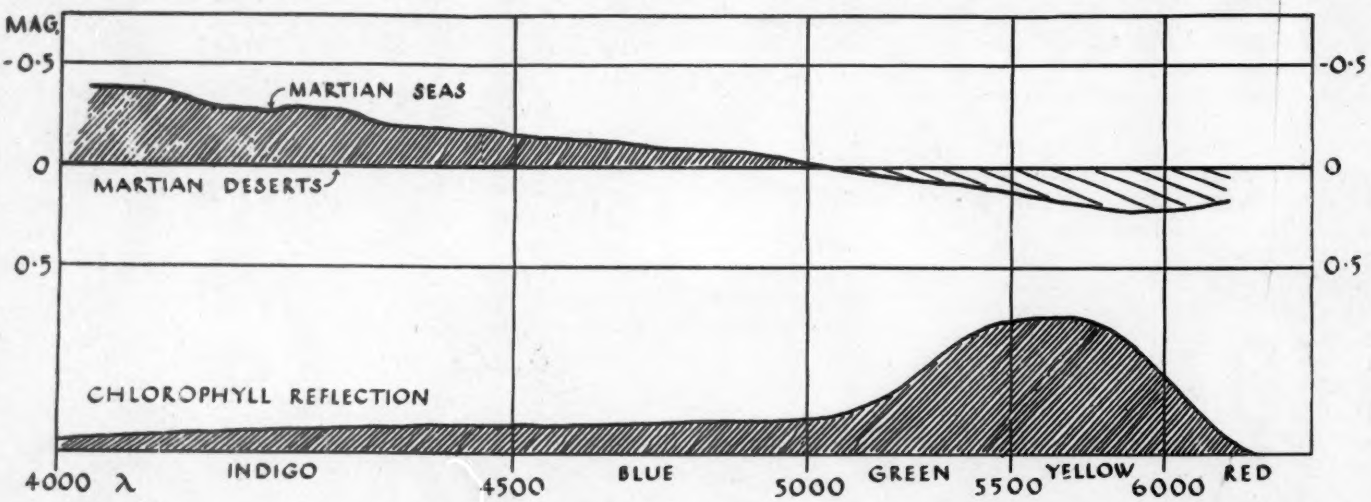
Mars' polar caps were first noticed in 1719, although it was not until toward the close of the 18th century that Sir William Herschel observed how they change in extent with the progress of the Martian seasons. The polar caps are easily seen through a medium-sized telescope of long focus, first one polar cap and then the other, for Mars' axis is inclined 25 degrees to the perpendicular to its path around the sun. The south polar cap has been observed to disappear entirely during the summer season in that hemisphere, although some of the northern cap always remains. This might be expected since, due to the eccentricity of its orbit, Mars is nearer the sun during its southern summer than during its northern summer. At the present opposition, this month on the 17th, the north polar cap will be directed toward the earth.

In the same year that Schiaparelli described the *canali,* Asaph Hall discovered Mars' two tiny satellites, Phobos and Deimos, at the United States Naval Observatory. During the last quarter of the 19th century great excitement surrounded every new observation concerning the ruddy planet. This new interest was increased by Percival Lowell, who founded an observatory at Flagstaff, Ariz., in 1894, where he and his associates made a detailed study of the planet, which has been continued until the present day.

The word *canali* that Schiaparelli had used to designate the strange lines he had observed on Mars' surface can be translated from Italian as channels. However, the word was interpreted by many as meaning *canals,* which carried the implication that they were of artificial construction, like the canals with which we are familiar on the earth. This opened the way for speculation as to the possibility of intelligent beings on the planet, although it appears that Schiaparelli thought of the markings only as geological formations on Mars.

Lowell made extensive observations of Mars and described the so-called canals in great detail. He drew charts and built globes showing how the markings on the planet appeared to him. He also noted the varied shadings and irregular coloration of the planet and observed how these changed with the Martian seasons. And he wrote extensively on what he saw, expressing his theory that the canals were waterways constructed by intelligent beings for the express purpose of carrying water from the regions of the polar caps to the arid areas of the planet. This idea appealed greatly to the popular imagination and Lowell's writings were widely read by both scientists and laymen. They inspired some of the thrillers by the late H. G. Wells and have left an impression on the public mind that lingers even today.

Unfortunately, however, there were many astronomers who did not observe the canals as Lowell described them. Some observers could not see them at all and others saw them only imperfectly. Today, however, some of these markings have been photographed and



A chart showing the negative results obtained by Dr. Peter M. Millman, while at the David Dunlap Observatory, as to the possibility that the visual green observed on Mars comes from plant origin. The upper part compares the radiation from Martian "seas" and "deserts" for various wave lengths, showing the blueness of the light from the darker "seas." The curve is the mean of four evenings' observations, June 18, 22, 25, and August 3, 1937. The lower curve shows the reflection of light from the chlorophyll in terrestrial foliage — strong in the green and yellow, just where the dark Martian areas are weak.

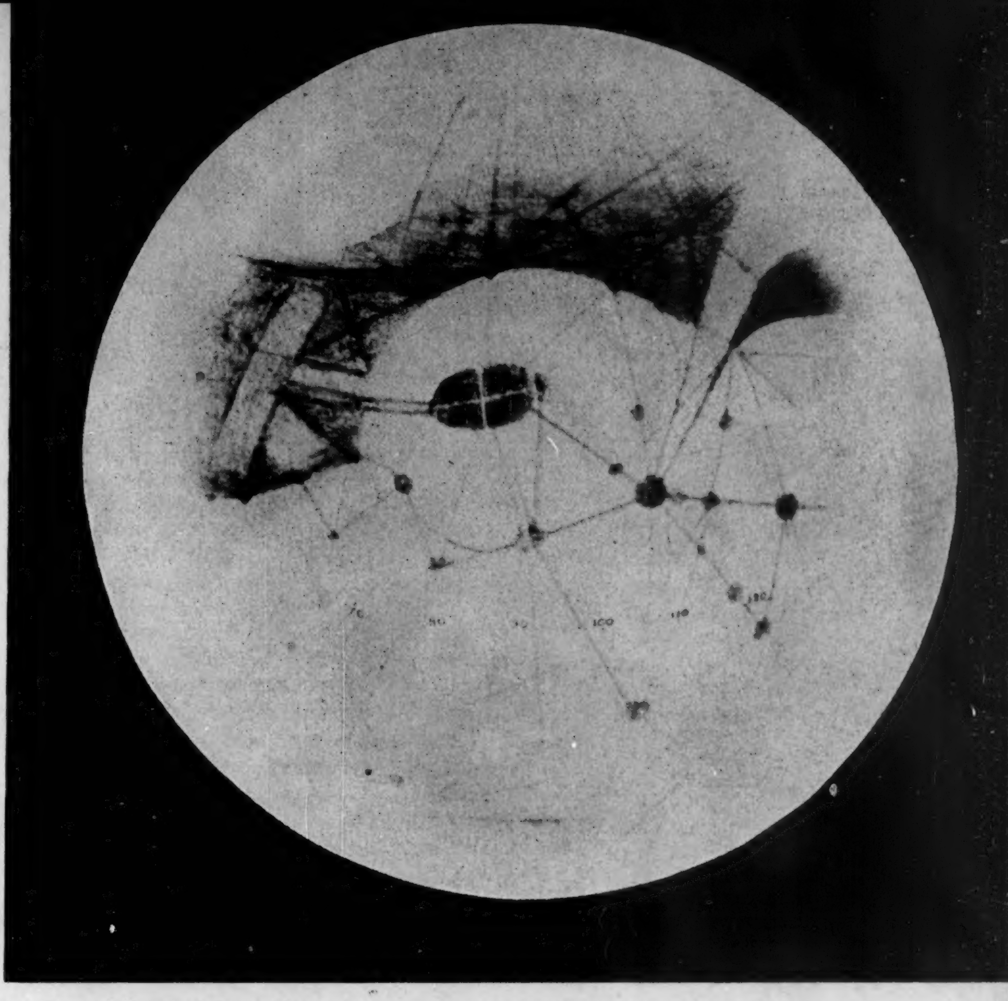
their existence is definitely proved. The photographic plate, however, does not reveal all of the detail that can be glimpsed with the eye during certain rare moments of good seeing. Perhaps the 200-inch telescope will be able to take instantaneous exposures showing some of the elusive detail on Mars.

The difficulties encountered in exploring Mars are numerous. When it is on the far side of its orbit, beyond the sun in space, it has an angular diameter of only a few seconds of arc. It is only before and after opposition, that is, for only a few weeks every two years and 50 days, that the planet is in a good position for observation. Even then, really favorable oppositions occur only once or twice in 15 or 17 years. At the opposition this month the planet's apparent diameter will be about 14 seconds of arc, whereas at the most favorable oppositions it may be nearly twice as much. As described last month, the opposition of March, 1950, will find Mars nearer the earth than it is now. And so at each successive opposition, in 1952 and 1954, it will be still nearer, reaching its most favorable approach in September, 1956. During that opposition there will undoubtedly be much popular interest shown, and it is likely that with the many advances in instruments and technique new and startling discoveries will be made.

Mars, with a mean diameter of about 4,200 miles, is much smaller than the earth, and its gravitational force is about two fifths that of our planet. The velocity of escape at Mars' surface is about three miles per second, less than half that on the earth. This indicates that the Martian atmosphere should be less extensive than ours, which is confirmed by observation. We see down through the Martian air to the surface of the planet, where the predominantly ruddy color gives Mars an individuality that distinguishes it from the other planets.

The darker Martian areas have generally been given aquatic names, such as seas, lakes, or bays. Lighter regions are described as land or desert. More than half of the surface is orange, but there are also shades of green, brown, and other hues. The canals seem to cross the seas as well as the land.

In spite of the fact that the problem of Mars' markings is unsolved, recent studies have yielded much new information. The result of spectroscopic observations have mostly been negative, but nevertheless important. Studies made by Adams at Mount Wilson in 1933 failed to detect oxygen or water vapor — oxygen present could not have been as much as 1/10 of one per cent of the quantity in our atmosphere. Some astronomers believe the ruddy color of Mars may indicate that much of the original oxygen has been captured by the surface materials through oxidation.



One of Percival Lowell's typical drawings of Mars, showing the "canals," well-defined and straight, making a network over the surface of the planet. Courtesy of Lowell Observatory.

The polar caps seem to be composed of some form of water: snow or hoarfrost which melts during the Martian summer. Various color changes in the regions of the canals and elsewhere suggest the possibility of vegetation springing to life with the approach of the summer season and then dying off in the autumn.

Ultraviolet photographs show that clouds sometimes exist in the atmosphere of Mars, and also that something in the nature of a cloud bank or perhaps a heavy mist hangs over the polar caps. Photographs in infrared light reveal what appear to be huge dust clouds near the surface of the planet. These have been seen to move across the face of Mars as if driven by violent winds.

There is a great variation in Mars' temperature from day to night. Measurements with the thermocouple indicate that near the equator at noon it may be as warm as 50° or 60° F. In the twilight zone at sunrise, the temperature has been computed as around 120° below zero.

Recent studies by Dr. G. P. Kuiper, of the Yerkes and McDonald Observatories, using an infrared spectrometer with a Cashman lead-sulfide cell, have indicated quantities of carbon dioxide in the atmosphere of Mars as plentiful as on the earth. There is no trace, however, of methane and ammonia, which are present in the atmospheres of Jupiter and Saturn. At this year's opposition, Dr. Kuiper plans to make extensive studies to search for the presence of vegetation on Mars.

Many astronomers at present do believe that Mars may support vegetable life of some form. H. Spencer Jones has described it as "the planet of spent life," where there are probably some plant forms today but where, we may imagine, there may once have existed more complex forms of animal life.

Mars appears to have lost none of its dramatic interest since the days of Percival Lowell. If modern astronomers are more reserved in their interpretation of what they see, it is merely because they have learned that it is best to approach such problems with caution.

NOTICE

Some defective copies of the January **Sky and Telescope** may have been sent to subscribers in error. If your copy is imperfect, please write us for a replacement.

As we go to press, there is no way of knowing whether or not the Boston truck strike will be settled in time for this issue of **Sky and Telescope** to be delivered to the bindery and the post office on schedule. If your magazine has been unduly delayed, we regret that the matter is beyond our control.

BOOKS AND THE SKY

THE NAMING OF THE TELESCOPE

Edward Rosen. Henry Schuman, Inc., New York, 1947. 110 pages. $2.50.

THIS SMALL BOOK is precisely what its name indicates, the story of the circumstances and persons connected with the first application of the name "telescope" to the instrument now known to us by that name. One might suppose that there is no story here, or one which could be told completely in a few lines. But we can recall the uncertainty still surrounding the real discoverer of the telescope itself, related briefly in Grant's **History of Physical Astronomy,** Chapter XX. Grant does not mention the origin of the name, but one of those claiming the discovery of the telescope, Porta, plays an important part in Dr. Rosen's story. Here, too, there exists a tangle of conflicting evidence involving obscure language, probable poor memory, and propaganda, to be sifted as best possible.

The discussion of the problem fills 71 pages. This is followed by 27 pages of notes involving incidentally a bibliography on the subject. Those who are willing to accept the reasoning of Dr. Rosen in the text and agree with his conclusion need not give much attention to the notes. The case is presented clearly and logically and in detail. I believe that very few will be disposed to question the validity of his conclusion; but should anyone wish to go into the matter more deeply the notes provide a mass of references bearing on the subject from which he could reach his own verdict.

These sources involve several languages, but primarily Italian and Latin. Some of them are quite difficult of access, some not available at all in this country. To collect these sources and to consult them evidently represents much hard work on the part of the author. The chief difficulty, however, was in the effort to reconcile or explain statements in apparent or real conflict. The author feels reasonably sure of his conclusion but admits and points out some weak points.

Perhaps I should make the reader get the book to learn the result of his investigation, and this is highly recommended, yet I am sure that some will read this who will not read the book so I give the important statement, put in italics by the author, namely: "the term telescope was originally devised by [John] Demisiani and publicly unveiled by [Frederick] Cesi at the banquet in Galileo's honor [in Rome] on April 14, 1611."

The decision lies between these two persons, some attributing the name to one and some to the other in early writings. Later writers differ correspondingly. Future writers should heed Dr. Rosen's statement above. The name first appeared in print in J. C. Lagalla's book **Lunar Phenomena,** published in Venice in 1612.

Although the word telescope originated in Italy it is not the ordinary Italian word, which is **cannocchiale, telescopio** applying to reflectors only. Similarly, in France **telescope** refers to a reflector, a refractor being called **lunette.** In German the common word is **fernrohr.** In English **telescope** applies to either type.

One must admire the thoroughness with which the author has carried out his investigation. It was done under a fellowship which was granted to him by the John Simon Guggenheim Memorial Foundation. He is already known as the author of **Three Copernican Treatises,** and he is at present preparing an edition of **Revolutions of the Heavenly Spheres.**

SAMUEL G. BARTON
Flower Observatory
University of Pennsylvania

ASTRONOMY

William T. Skilling and **Robert S. Richardson.** Henry Holt and Co., Inc., New York, 1947. 692 pages and star charts. $4.75.

SIXTY PER CENT of the teachers who have used the first edition of this up-and-coming textbook and who were queried by the authors in 1944 as to desirable revisions answered the questionnaire concerning changes of the first edition. There was more than 70 per cent agreement on half of the questions, and the authors produced a second edition improved in many respects over the first. The new book is probably more up-to-date than any other standard text on astronomy, and embodies such recent events as the current sunspot maximum.

Astronomy today is expanding so rapidly that no text can cover all of it as completely as might be ideally desirable; for use in a year's astronomy course the practically 700 pages of Skilling and Richardson's compilation provide abundant material, both factual and explanatory, but all of it is presented in relatively simple language. The diagrams are in many cases refreshingly new, and it is evident that the authors have spared no effort in putting as much explanation and fact into each discussion as is possible.

Leading off the second part, which treats of the physical nature of the sun and the planets, is a chapter entitled, "Light, Atoms, and Spectrum Lines." Here has been included basic material on nuclear physics and the structure of the atom. As might be expected from the vicinity of Mount Wilson Observatory, the treatment of the sun and the origin of sunspots is exceptionally complete. Prominences and the corona are also discussed rather well, with a list of the identification of 23 lines in the coronal spectrum, after Edlén.

In the third part of the book, dealing with stellar astronomy and galaxies, we are impressed with the combination spec-

Planetarium Notes

ADLER PLANETARIUM

900 E. Achsah Bond Drive, Chicago 5, Ill. Wabash 1428

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m.

STAFF: *Director,* Wagner Schlesinger. *Other lecturer:* Harry S. Everett.

February: WHAT ARE STARS? In this demonstration visitors learn not only what we know about stars but also how this knowledge is obtained.

March: THE SEASONS.

BUHL PLANETARIUM

Federal and West Ohio Sts., Pittsburgh 12, Pa. Fairfax 4300

SCHEDULE: Mondays through Saturdays, 3 and 8:30 p.m.; Sundays and holidays, 3, 4, and 8:30 p.m.

STAFF: *Director,* Arthur L. Draper. *Other lecturers:* Nicholas E. Wagman, J. Frederick Kunze.

February: SKIES OF WINTER. Visitors renew their acquaintance with the stars of winter. MIRRORS IN THE SKY. A sky show designed to help celebrate Latin Week in western Pennsylvania.

March: MARS AND SATURN — MYSTERY WORLDS, and THE STORY OF EASTER.

FELS PLANETARIUM

20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Rittenhouse 3050

SCHEDULE: 3 and 8:30 p.m. daily except Mondays; also 2 p.m. on Saturdays, Sundays, and holidays. 11 a.m. Saturdays, Children's Hour (adults admitted).

STAFF: *Director,* Roy K. Marshall. *Other lecturers:* I. M. Levitt, William L. Fisher, Armand N. Spitz, Robert W. Neathery.

February: AROUND THE WORLD IN 50 MINUTES. This show utilizes the ability of the planetarium to portray the stars for any part of the earth. Stops will be made at the poles, the equator, and in Australia.

March: THE EASTER STORY.

GRIFFITH PLANETARIUM

P. O. Box 9787, Los Feliz Station, Los Angeles 27, Cal., Olympia 1191

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m. Extra show on Sunday at 4:15 p.m.

STAFF: *Director,* Dinsmore Alter. *Other lecturers:* C. H. Cleminshaw, George W. Bunton.

February: THE SEASONS. The audience watches the changes of the seasons and learns their causes. A journey to the Southern Hemisphere illustrates the reversal of the seasons.

March: THE STARS OF SPRING.

HAYDEN PLANETARIUM

81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.

STAFF: *Honorary Curator,* Clyde Fisher. *Chairman and Curator,* Gordon A. Atwater. *Other lecturers:* Robert R. Coles, Catharine E. Barry, Shirley I. Gale, Edward H. Preston.

February: A TRIP TO MARS. What is it like on Mars? The Hayden Planetarium is conducting an imaginary trip to this mysterious planet. It is an adventure strictly out of this world.

March: RADAR, METEORS AND COMETS.

tra and diagrams of Zeta Aurigae on page 577, also by Fig. 272, showing the physical appearance of the luminous ring of RW Tauri. But the eight photographs of exterior galaxies on page 652 seem to have suffered considerably in reproduction. Elsewhere in the book this same manufacturing imperfection shows, as with the comets on page 458.

The star charts are well done, except the blue background is too dark for easy reading of the names and Greek letters. We wish the frontispiece had a caption right with it, but gladly accept it without in exchange for the four-page glossary of astronomical terms, which is only one of several important appendices.

Skilling and Richardson's **Astronomy** can be highly recommended. And apparently this opinion can be held for further editions, for the authors state they "want the book to keep abreast of future developments in an advancing science."

C. A. F.

THE STRANGE STORY OF THE QUANTUM

Banesh Hoffmann. Harper & Brothers, New York, 1947. 238 pages. $3.00.

THE PURPOSE of Dr. Hoffmann's book as set forth on the jacket is to give "an account for the general reader of the growth of ideas underlying our present atomic knowledge." However, the reviewer feels that although the book has something to offer both to the expert and to the layman, the "general reader" will find the going altogether too rough for comfort.

The early chapters, dealing with the wave-particle controversy over the nature of light, and the atom as pictured by Bohr and Sommerfeld, may be followed without too much difficulty. At this point the author warns the reader that in what follows, "The going will be rough, but I can promise you excitement aplenty. So hold tight to your seat and hope for the best." I am afraid that the author loses most of his riders within a very few pages beyond this point. For example, his device to liken Heisenberg's matrices to laundry lists is amusing, but hardly illuminating to the reader. The author attempts to explain such things as the principle of indeterminacy, the wave atom, and the theories of Dirac, in language that will make these abstruse ideas clear to the general reader, but I feel that he falls far short of his objective.

Taken as a whole the book is certainly entertaining and often very amusing. Perhaps the author is not to be blamed for its shortcomings, for the task he has attempted is practically impossible — even for a Gamow. Taking a leaf from Professor Gamow's books, however, Dr. Hoffmann might well have included many additional drawings as an aid to the reader.

CARL K. SEYFERT
Barnard Observatory
Vanderbilt University

NEW BOOKS RECEIVED

STAR STORIES, *Gertrude C. Warner,* 1947, *Pilgrim Press.* 64 pages. $1.25.

A completely rewritten and revised edition of a child's first guide to the stars. Children are invited to learn to identify 19 constellations and four planets.

AN OUTLINE OF STELLAR ASTRONOMY, *Peter Doig,* 1947, *Hutchinson's,* London. 168 pages. 10s. 6d.

A survey of present knowledge of stars, nebulae, the Milky Way, and external galaxies, first published in 1927 and now completely revised.

ELEMENTS OF MATHEMATICAL ASTRONOMY, *Martin Davidson,* 1947, *Hutchinson's,* London. 224 pages. 15s.

Employing only simple mathematics, this book expounds the principles of mathematical astronomy. Its second part contains an elementary treatment of relativity, useful in understanding more complex discussions of the subject.

THE LIFE AND TIMES OF TYCHO BRAHE, *John Allyne Gade,* 1947, *Princeton University Press* and *American-Scandinavian Foundation.* 209 pages. $3.50.

A book written to commemorate the 400th anniversary of the great Danish astronomer. It is written by the author of *All My Born Days, Cathedrals of Spain, Charles XII,* and *King of Sweden.*

THE SCIENTISTS SPEAK, editor, *Warren Weaver,* 1947, *Boni and Gaer.* 369 pages. $3.75.

A collection of the science talks broadcast in recent years during the Sunday afternoon New York Philharmonic programs has been organized into 15 chapters covering many phases of scientific advance, with a short introductory section to each chapter by Dr. Weaver.

TERMINOLOGY TALKS

(Continued from page 97)

the heavens is known as the ecliptic. The term comes from the same source as "eclipse," since the moon must be on or near the ecliptic for an eclipse to occur.

Equinoxes

The sun appears to move eastward entirely around the ecliptic in a year. This circle may then be defined as the sun's apparent annual path among the stars. The points of crossing of the celestial equator and ecliptic — it is there the sun is said to "cross the line" — are known as the equinoxes. When at the vernal equinox about March 21st, the sun is moving north across the celestial equator; when at the autumnal equinox around September 23rd, it is going south.

COLUMBUS MEETING

(Continued from page 93)

some of the problems which faced European astronomy at the close of World War I; and on Dr. Trumpler, who discussed the considerable perturbations necessary to deflect the American Astronomical Society from its normal eastern orbit to the remoteness of California. A feature of the evening was the presentation of two motion pictures, one by Dr. D. H. Menzel, of Harvard, of solar prominences, and the other by Dr. Minkowski, Kodachrome pictures by Edison Hoge of the moving of the 200-inch mirror to the top of Palomar Mountain. The mirror is now in the telescope and preliminary testing and adjustments have begun.

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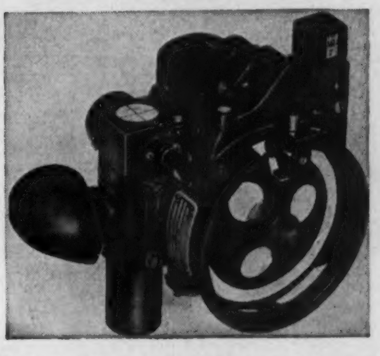

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A Kansas City Amateur's Observatory

SIXTEEN YEARS AGO, I chanced to read an article in **Scientific American** which told how anyone, with ordinary mechanical ability, a little spare cash and a lot of patience, could construct with his own hands a very useful astronomical telescope. This seemed wonderful to me as I had always considered that such an instrument belonged only in a professional observatory and that it could be made only in an optical shop. The same article also told about the book **Amateur Telescope Making**, in which I found the directions so simple that I set to work at once grinding a 6-inch mirror. The glories revealed in the sky by this new reflector, the first one larger than a small eight-power refractor that I had opportunity to look through, only served as fuel to a desire for a larger mirror with greater light-gathering power.

A search then began for a piece of glass thick enough and large enough for a 12-inch mirror. In time a jagged piece 1⅜" thick was found in a dusty corner of the warehouse of a local glass company, which together with a thinner glass was obtained for a couple of dollars. An improvised cutter was set up in the basement and the two 12-inch disks cut out. The thinner one was cemented with pitch to a concrete block, and the one which was to be the mirror was cemented to a round wooden block which was used as a handle, and the rough grinding began.

A full year of my spare time was consumed in making the principal mirror, which I felt must have the best figure that it was possible for me to give it because astronomy was my interest, telescope making only a means to an end. The mirror was almost completed when an article appeared in the Sunday Kansas City **Star** telling of the activities of several amateur astronomers here in Kansas City who were working on telescopes. I looked them up at once, being hungry for company in this hobby and feeling the need of the ideas of others in the making of a telescope of this size. The exchange of ideas and the mechanical abilities of the members of this group (some of whom had precision machine tools) aided all of us greatly in solving our problems.

At the start, a Newtonian-Cassegrainian combination was decided upon as the best type for both high and low power. The principal mirror was given a focal length of 109½ inches, very long for a Cassegrainian. It projects an image of the full moon ⅞" in diameter at the Newtonian focus and 3" in diameter at the Cassegrainian focus, these diameters varying with the moon's distance from the earth. Each focus is provided with a 3" x 4" box moved by rack and pinion, to receive either filmholder or eyepiece. The Newtonian flat mirror is located about two feet in front of the prime focus, and, instead of being placed at the conventional 45-degree angle to the optical axis, it was set at 10 degrees so that the cone of light was reflected out at 20 degrees to the tube. This enables the observer, with the aid of a rotating star diagonal, to stand on the floor or a very low stool and view any part of the sky. The Newtonian flat mirror was fixed on a hinged arm directly in front of the Cassegrainian secondary mirror and when the Cassegrainian focus is to be used, the flat is swung down into a pocket in the side of the tube, thus leaving the fixed convex mirror exposed to the reflected cone of light. A 2½" right-angle prism, fixed in the optical axis about 18" in front of the principal mirror, then re-

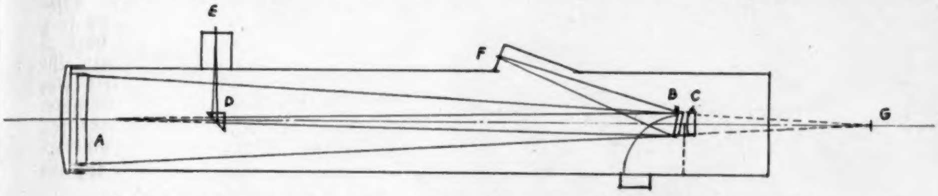
The heavy fork mounting of Mr. Tarbell's 12-inch reflector. The Cassegrainian eyepiece holder and the guiding telescope are at the upper left.

EDITED BY EARLE B. BROWN

flects the cone of light out to the Cassegrainian focus. A full image of the sun or moon cannot be photographed at one time at this focus because the circle of light is not quite large enough. The Cassegrainian focus, being near the supporting axis of the tube of the telescope, may be used by the observer on any part of the sky while he is sitting on a stool. Both secondary mirrors are 3⅛" in diameter. Change-over from one focus to the other may be made within a few seconds. The finder is a 1¾-inch refractor of excellent quality, purchased at a pawnshop. The larger refractor attached to the tube has a 3-inch camera lens and a high-power eyepiece with cross hairs at the focus. It has great light-gathering power but the quality of the star images is poor; it is used only for guiding in connection with star photography. All the mirrors were aluminized in 1937, and still look bright and are in useful condition.

A stable mounting for a 12-inch reflector really proved to be a jinx to such an inexperienced hand as I was. Nor had any of the others of our group ever mounted so large a telescope. Trial and error and much wasted time on a shaky mounting finally led, over a period of three years, to the construction of a very stable open fork equatorial mounting having a really steady movement. The fork consists of two 9" channels fastened by iron castings to a 16"-diameter base plate. By means of a ball thrust bearing on a 1" steel center pin, the base plate is held in contact with a larger steel plate which is turned by the clock drive. The clock movement is driven by an electric phonograph motor which runs at constant speed under a negligible load. Speed of the clock drive is regulated by an arm which slips a small belt, from motor to drive, up and down on slightly cone-shaped pulleys. Electric current for lights and power is provided by an underground parkway cable from the house to the base of the telescope.

The declination setting circle is equipped with a vernier which allows a reading to five minutes of arc. The right ascension circle, located around the base of the yoke, is divided into hours and minutes of time. Setting of the right ascension circle for the



Scheme of the Tarbell telescope. A, mirror. B, Newtonian flat. C, Cass. secondary. D, Cass. diagonal. E, Cass. focus. F, Newtonian focus. G, primary focus.

evening's work is done as follows: After the clock is started, a removable pointer arm is sprung onto the clock-driven plate at the base of the mounting, the pointer just touching the graduations of the circle. At the upper end of the pointer arm is fixed a large magnifying glass which enables the observer to read the graduations on the circle while standing. The telescope is next focused on a star whose position is known, and the setting circle slipped around on its collar to a point where the star's location in hours and minutes coincides with the pointer. The telescope is now ready for use in setting on any given star location as long as the clock continues to run. The setting circle moves with the telescope while the pointer moves with the turning of the earth, and they stay together as long as the telescope is focused on a given object. Hand-operated slow motions allow the observer to move the instrument slowly in either direction while viewing an object.

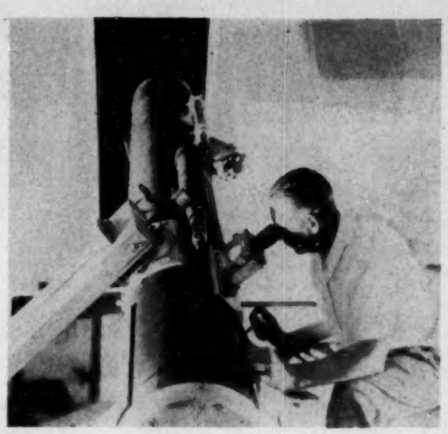
The tube and yoke are also independent of these slow motions, and the telescope may be swung quickly to any part of the sky by hand. There is no movement whatever in the field of view of the eyepiece or any lagging when the mirror is focused on an object while the clock is running, because all backlash in the gears of the clock is eliminated through the clock's continuous pull in a forward direction. Friction due to the heavy cantilevered weight of the combined yoke and tube was reduced to such an extent by four rings of 3/8" ball bearings placed between the two plates at the base of the yoke that the telescope can be swung quickly in either direction without putting any backlash in the gears of the clock.

As time went on various accessories were made, such as a solar eyepiece with a Herschel wedge, a sliding filmholder with ground glass, a focal-plane shutter for sun photography, and so forth.

At the time the fork mounting was completed we lived in the south part of Kansas City and had a very good location for an observatory, since our backyard was shielded from all street lights by other houses. Many of our meetings were held there, others of the group bringing telescopes with portable mountings. In 1941, a chance came to trade our property for a 10-acre tract of land situated on high ground in the suburbs east of the city. Apart from a desire for the open spaces shared with the rest of the family, the writer always had had in mind securing a good location for an observatory. After we moved, the telescope was set up in a permanent location on a two-ton base of concrete which reached down into the ground 7½ feet. A mound of earth was then built around it 20 feet in diameter and paved with asphalt. The sheet-iron house which rolled on a track, moved from our other place, provided shelter for the instrument when not in use.

In our new location, the wind seemed to blow continuously. Wind, of course, renders star photography impossible for the slightest quiver of the tube is magnified to the same extent as the object being photographed. Hence a dome seemed to be the only solution to the problem. After the war, I heard that several amateurs had equipped their observatories with metal silo tops, so I contacted a silo salesman and ordered one of these. It had a maximum spread of 16' 8" or 200 inches, which is just the size of the largest telescope mirror in existence. A concrete base was then poured to receive a dome of this size. After waiting about four months, the writer was informed that the silo company had decided not to make a dome of these dimensions at this time. Despairing of buying a ready-made dome of the right size to fit my concrete base, and finding that 20-gauge sheet iron was available, I decided to try to make one myself. After much preliminary figuring, a full-sized template of a gore was made (again through trial and error). Twenty-four gores were cut out to this pattern. Since it was not practical to have the gores sheared out in the shop, due to the hyperbolic shape of their sides, they had to be cut with hand shears and, believe me, 20-gauge iron is about as heavy as one wants to shear by hand.

The manner in which the dome was designed required no stiffening ribs. The only rolled-steel angle work needed was the 3" x 3" x ¼" angle carrier ring to which the skirt of the dome was bolted and the 2" x 2" x ¼" angle frame around the opening. The strength of the structure was derived from 1" standing seams or flanges turned up on each side of the gores and held together with ¼" stove bolts in the final assembly. The flanges were hammered into each gore while it was held to its final curved shape in an improvised jig. The gore then held its shape rigidly when removed from the jig. Before as-



Mr. Tarbell observing at the Cassegrainian focus of his instrument.

sembly each gore was given two coats of red lead, and after erection the whole structure was painted with aluminum paint.

Thus another year of my spare time was well spent, for wind is no problem now and the cold winter nights do not seem so bitter. The whole dome rests like a large inverted pan on fixed steel ball-bearing rollers, which are fastened to the top of the concrete wall with expansion bolts. It turns very easily although weighing about 1,000 pounds, and no mechanical drive unit is needed. The opening slot is 30" wide in the clear and the cover rolls over the top to clear the opening for observation. The "bugs" have not yet been gotten out of the sliding cover and it rolls very hard. The addition of long springs and arms, which start the cover up easily and which catch it as it goes down the back side of the dome, help a lot but do not solve the problem entirely. They do serve, however, to prevent one from getting trapped by the falling cover some night when no one else is around. I hope soon to have in operation a chain drive with which to crank the cover open and shut.*

The name "Twin Cedars" was suggested for the observatory because of the two large old cedar trees in our front yard.

An interesting stunt was conceived while the concrete of the base of the present mounting was being poured. A "time capsule" was prepared out of a heavy copper box having a close-fitting lid that screwed on, which had been lying around the house for several years. In the box was placed a letter to the future telling of conditions in the world of our day, together with various magazine clippings, photographs, coins, a complete copy of the Kansas City **Star,** and a copy of the King James version of the Bible. Several present star locations were given in the letter. The box and its contents were thoroughly dried, then the box was sealed up and coated with hot pitch and placed in the center of the concrete base, to be opened maybe in a few years or several centuries, maybe never.

E. D. TARBELL
Hunter Ave. and Leeds Road
Kansas City, Mo.

*Ed Note: On page 35, *Sky and Telescope,* December, 1947, there is a photograph of the dome of Mr. Tarbell's observatory, accompanying a report on the recent activities of the Kansas City Astronomical Society.

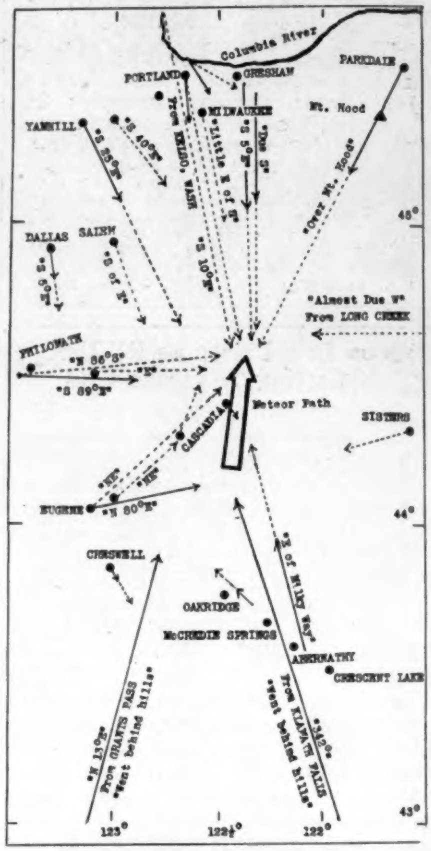
OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

THE BLUE CASCADE METEOR — NOVEMBER 22, 1947

AT 1:10 A.M., November 22, 1947, a huge fireball flashed across the skies of Oregon. Within 48 hours after the meteoric display, the American Meteor Society asked the press to request observers to mail in their accounts to the writer, AMS regional director. Within a few days, exactly 50 reports had arrived.

Usually the first report from any observer gives very little desired information, but questionnaires sent to those reporting bring, in most cases, azimuth and altitude estimates and actual measurements which are quite useful in determining the ground path (territory over which the meteor passed while luminous), heights at various parts of the flight, and so forth, which are quite helpful in plotting the fireball's course. Note, on the accompanying map, the general convergence of the disappearance arrows toward a region a little north of Cascadia. Since all observers did not catch sight of the object at the same instant, the appearance arrows on a map of this type do not often converge well and the starting point is harder to determine than the end point. The directions alongside the arrows are those stated by the observers or measured on diagrams they furnished. Some of the arrows are at variance with the general run of them; the observers were in some cases in strange places where accurate directions were not known. But enough do follow a general pattern to give the tracer an idea of what was happening.



The approximate ground path of the fireball of November 22nd is marked by the wide block arrow. Solid arrows indicate directions in which observers at various locations reported the fireball as first seen; arrow lengths have no significance. Dotted arrows indicate the directions of the point at which the meteor was observed to disappear. Plotted by the author and A. H. Kunz, assistant director, Pacific region, American Meteor Society.

In the case of the fireball under consideration, practically everyone who had anything but strictly a side view of it reported that it seemed to be falling vertically. This is shown on the map where the solid and dotted arrows from any station are in the same line. Yamhill and Parkdale and others between thought it fell "straight down." Three or four from the Portland area indicated that it had a slight shift toward the east. Philomath reported the meteor descending at an angle of 65 degrees. From the angles of altitude we deduced that it probably became luminous at about 70 miles, descending sharply with a very short ground path, and in three or four seconds "blinked out" at approximately 20 miles altitude. Cascadia reported the fireball passed "within one degree of the zenith." At Parkdale, only 12 miles northeast of 11,245-foot Mt. Hood, it was observed that "the snowy peak suddenly emerged from darkness and gleamed in full brilliance under the rays of this aerial lantern." The descent is shown as vertical over the western slope of the mountain in the diagram received. At Yamhill, quite unlike many others, one observer wrote, "It was a considerable distance away."

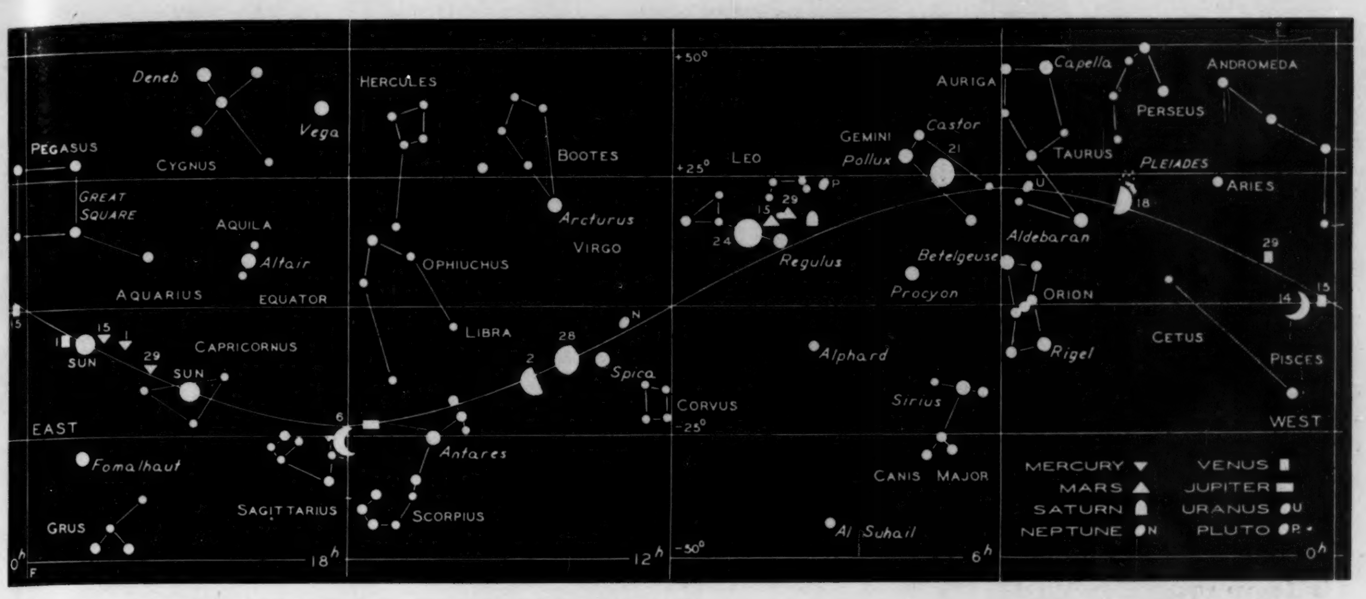
Nearly everyone emphasized the extreme blueness and brilliance of the light. Since the entire Pacific Northwest was under unusually clear skies that night, the phenomenon was widely observed despite the lateness of the hour. A few of the more interesting statements were:

"Flame following behind was as big as a telephone pole." "Old Baldy Mountain, several miles away, looked as light as day." "It was only 200 feet above a nearby field." "Like the light of an electric welder only multiplied a thousand times." "My report is not for publication." "My husband wanted to get out of the car and look for fallen pieces." "Seemed like the moon fell out of the sky." "Our prune orchard and our faces all turned blue." "We thought it would surely strike our house if it hadn't gone out."

J. HUGH PRUETT
University of Oregon
Eugene, Ore.

PHASES OF THE MOON

Last quarter	February 2,	0:31
New moon	February 10,	3:02
First quarter	February 18,	1:55
Full moon	February 24,	17:16
Last quarter	March 2,	16:35



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury reaches greatest elongation east on February 4th. Although it will be only 18° from the sun, setting time is 1½ hours after sunset. The planet then rapidly moves to inferior conjunction with the sun on the 20th.

Venus remains a bright evening object and now sets three hours after the sun. As viewed in a telescope, it appears in the gibbous phase.

Mars comes to opposition on February 17th, appearing between Regulus and Eta Leonis, less than a degree south of Eta. Oppositions of Mars in late February are unfavorable, as the planet is at aphelion. Its rapid retrograde motion brings it to within 7° of Saturn and an equal distance from Regulus by February 29th. Mars outshines the other objects, being −0.9 magnitude. A close conjunction of the moon and Mars may be viewed on February 23-24; the moon will occult Mars as seen from some places in the northeastern part of the country.

Jupiter rises from three to four hours before the sun and is the only bright planet in the morning sky.

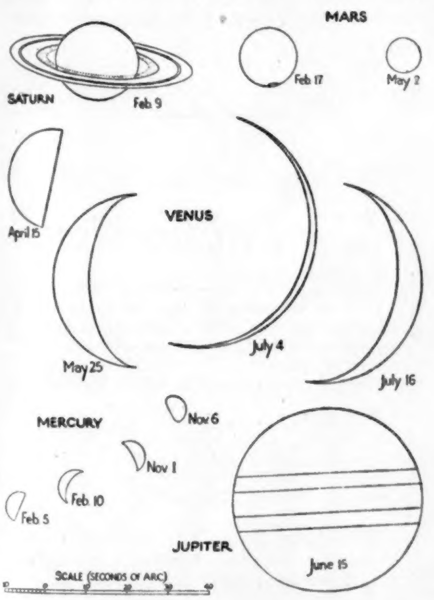
Saturn, a zero-magnitude object, may be found to the west of Mars and Regulus in Leo. Opposition occurs on the 9th and the planet will be above the horizon all night.

Uranus will be visible during the evening hours, located roughly one third of the way from Zeta to Beta Tauri. With optical aid, the planet appears a degree southwest of 121 Tauri, the star over half a magnitude brighter. See the next page for a chart of Uranus' path in 1948.

Neptune may be viewed after midnight near Gamma Virginis. Its position on the 15th is $12^h\ 49^m.3$, −3° 35′ (1948); the planet is 8th magnitude.

Pluto reaches opposition on February 5th.

E. O.



The telescopic appearances of the planets, from the 1948 "Handbook" of the British Astronomical Association. The images are inverted, with south at the top, as seen in a telescope.

VARIABLE STAR MAXIMA

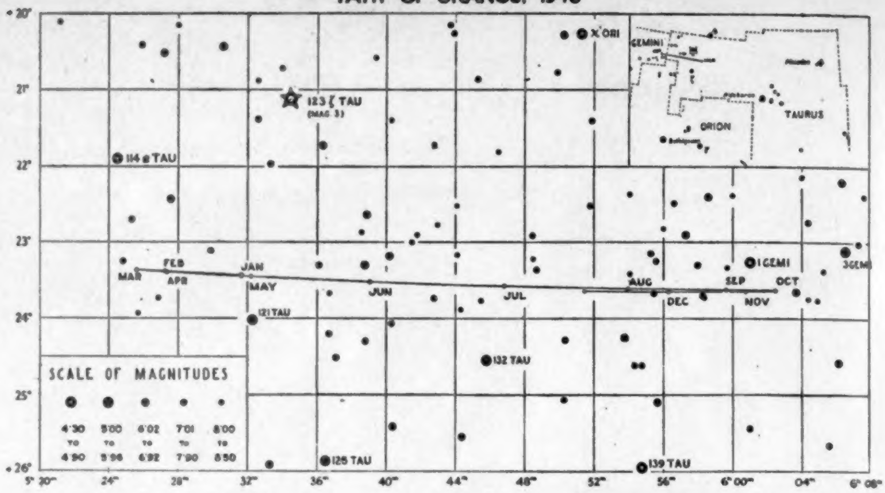
February 3, RT Hydrae, 7.6, 082405; 6, U Orionis, 054920a, 6.6; 11, RT Sagittarii, 7.9, **201139**; 18, V Ophiuchi, 7.5, 162112; 23, R Sagittarii, 7.2, **191019**; 24, V Cassiopeiae, 7.9, 230759; 28, R Corvi, 7.6, **121418**; 28, R Cygni, 7.3, 193449. March 5, R Geminorum, 7.1, 070122a.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

SKY-GAZERS EXCHANGE

PATH OF URANUS, 1948



The path of the planet Uranus among the stars of the zodiac during 1948, from the "Handbook" of the British Astronomical Association. The field is inverted, with south at the top and east at the right, as seen in an astronomical telescope. Uranus is about 6th magnitude.

OCCULTATION PREDICTIONS

January 31-February 1 **Lambda Virginis** 4.6, 14:16.3 −13-08.0, 21, Im: **E** 13:28.7 −2.3 −0.6 79; **F** 13:20.9 −2.3 −1.1 109; **H** 12:32.8 −1.3 −1.0 137. Em: **E** 14:27.9 −1.0 −2.5 341; **F** 14:42.2 −1.5 −2.1 317; **G** 13:45.6 −0.9 −1.2 330; **H** 13:54.4 −2.0 −0.9 298; **I** 13:37.7 −1.1 −0.8 315.

February 2-3 **Delta Scorpii** 2.5, 15:57.3 −22-28.5, 23, Im: **A** 13:47.5 −1.8 −1.3 115; **C** 13:43.6 −1.9 −1.3 122; **E** 13:16.3 −1.7 −1.0 133; **F** 13:22.1 −0.9 −2.5 166; **G** 12:45.2 −0.6 −0.2 147; **I** 12:43.4 +0.1 −0.9 165. Em: **A** 15:07.9 −1.3 −1.4 278; **C** 15:06.5 −1.5 −1.2 274; **E** 14:39.6 −2.1 −0.8 273; **F** 14:23.6 −3.4 +0.7 247; **G** 13:51.4 −1.8 +0.8 265; **I** 13:32.0 −2.1 +1.6 247.

19-20 **125 Tauri** 5.0, 5:36.5 +25-52.2, 10, Im: **A** 23:37.9 −2.6 −2.6 135; **B** 23:30.6 −2.1 −0.9 118; **C** 23:39.1 ... ... 155; **D** 23:20.2 −2.1 −0.6 119; **E** 22:57.8 −1.8 +0.1 114.

23-24 **MARS** −0.9, 9:58 +17-06, 14, Im: **A** 0:49.8 ... ... 180; **B** 0:40.7 −0.9 −1.5 159; **D** 0:38.8 −0.9 −2.3 167. Em: **A** 1:11.1 ... ... 220; **B** 1:21.6 −1.0 +2.7 241; **D** 1:10.8 −0.7 +3.7 231.

25-26 **b Virginis** 5.2, 11:57.3 +3-56.7, 16, Em: **A** 5:13.4 −1.5 −0.4 299; **B** 5:10.5 −1.2 −0.5 306; **C** 5:06.4 −1.8 +0.3 281; **D** 5:03.4 −1.4 0.0 292; **E** 4:43.7 −1.5 +1.5 264; **G** 4:36.2 −0.4 +0.9 290.

26-27 **k Virginis** 5.9, 12:57.0 −3-31.9, 17, Em: **E** 8:25.2 ... ... 25; **F** 8:52.5 −1.2 −1.9 330; **G** 8:04.6 +0.2 −2.4 2; **H** 8:17.2 −1.3 −0.4 303; **I** 8:05.5 −0.4 −1.1 341.

February 29-March 1 **172 B Librae** 5.9, 15:35.2 −20-50.8, 20, Em: **A** 11:22.0 −0.6 −3.4 3; **C** 11:27.9 −1.2 −2.4 345; **E** 11:08.6 −1.3 −1.3 328; **F** 11:07.3 −2.1 −0.7 298; **G** 10:38.2 −0.8 +0.1 314; **H** 10:24.5 −1.8 +1.0 270; **I** 10:30.5 −0.8 +0.5 298.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, GCT, **a** and **b** quantities in minutes, position angle; the same data for each standard station westward.

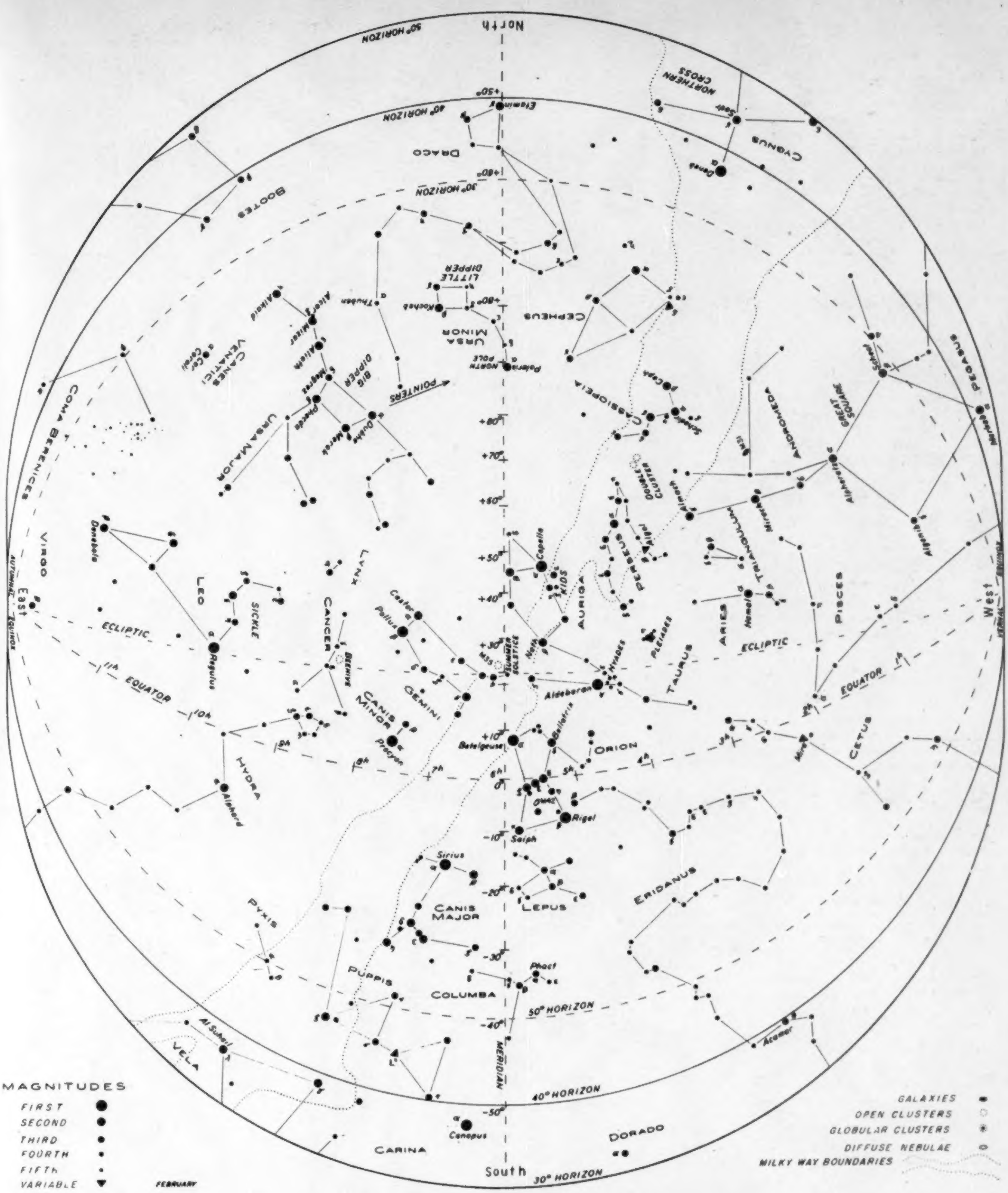
Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5		**E** +91°.0, +40°.0	
B +73°.6, +45°.6		**F** +98°.0, +30°.0	
C +77°.1, +38°.9		**G** +114°.0, +50°.9	
D +79°.4, +43°.7		**H** +120°.0, +36°.0	
	I +123°.1, +49°.5		

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

MINIMA OF ALGOL

February 2, 5:07; 5, 1:57; 7, 22:46; 10, 19:35; 13, 16:25; 16, 13:14; 19, 10:03; 22, 6:53; 25, 3:42; 28, 0:31. March 1, 21:21; 4, 18:10.



DEEP-SKY WONDERS

ONE of the older mysteries of astronomy has recently been cleared up by Helen Sawyer Hogg. In Messier's famous catalogue is a vague reference to M102, and no later astronomer has been able to identify the object. Recently, Dr. Hogg found a note by Méchain in the **Astronomische Jahrbuch** for 1786, in which he stated that the description for M102 actually belongs to M101 (**Sky and Telescope**, VII, 39). Thus is solved a mystery which has puzzled such eminent astronomers as Shapley, Gore, and Bailey.

Not content with this discovery, Dr. Hogg finds four more objects which may be considered as belonging to Messier's catalogue: **M104**, NGC 4594, 12^h $34^m.8$, $-11°$ 4′, spiral; **M105**, NGC 3379, 10^h $42^m.6$, $+13°$ 7′, spiral; **M106**, NGC 4258, 12^h $14^m.0$, $+47°$ 52′, spiral; **M107**, NGC 6171, 16^h $26^m.9$, $-12°$ 50′, globular. The original paper by Dr. Hogg, which deserves to be read by every amateur as a lesson in industry, appears in the **Journal** of the Royal Astronomical Society of Canada, September, 1947.

WALTER SCOTT HOUSTON

STARS FOR FEBRUARY

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m. local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. For the year 1948, these simplified charts replace our usual white-on-black maps, which may be consulted in issues of prior years when information on deep-sky wonders and less conspicuous constellations is desired.